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Midland, MI 48674

May 6, 2011

Ms. Mary Logan
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77 West Jackson
Chicago, IL 60604

**Re: Benthic Community Study Report-Settlement Agreement No. V-W-10-C-942
for The Tittabawassee River/Saginaw River & Bay Site
Dow Submittal Number 2011-030**

Ms. Logan:

Attached please find the Benthic Community Study Report prepared by The Dow Chemical Company (Dow) for the Tittabawassee River/Saginaw River & Bay Site. This submittal has been prepared in accordance with the requirements contained in Administrative Settlement Agreement and Order on Consent (AOC) and the Statement of Work (Attachment A of AOC) (effective January 21, 2010) ("Settlement Agreement"). Please let me know if you have any questions or concerns.

Sincerely,
The Dow Chemical Company

A handwritten signature in black ink that reads "Todd Konechne".

Todd Konechne
Project Coordinator

CC: Al Taylor, MDNRE
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**BENTHIC COMMUNITY
STUDY REPORT**



**PREPARED BY:
TITTABAWASSEE & SAGINAW RIVER TEAM**

**PREPARED FOR AND SUBMITTED BY:
THE DOW CHEMICAL COMPANY**

MAY 6, 2011

DOW SUBMITTAL NUMBER :

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Contents

	Page
Executive Summary	12
1 Introduction	14
1.1 Benthic Community Study Objectives	14
1.2 Technical Guidance	15
1.3 Reference Site Approach	17
1.4 Report Organization	17
2 Benthic Habitat Assessment Methods and Results	18
2.1 Sampling Locations	18
2.2 Habitat Assessment Approach and Results	19
2.3 Sediment Characteristics and Water Quality Related to Habitat Assessment	20
3 Benthic Community Sampling Methods and Data Analysis Approach	22
3.1 Benthic Community Assessment	22
3.1.1 Benthic Grab Samples	22
3.1.2 Artificial Substrate Samples	23
3.1.3 Sweep Samples	23
3.1.4 Sample Handling and Shipment	24
3.2 Data Analysis	24
3.3 Taxonomic Analysis	25
3.3.1 Benthic Community Metric Descriptions	26
3.3.2 Data Organizational Approaches	28
3.3.3 Two EPA and DNRE Multi-Metric Scoring Approaches	28
3.3.4 Statistical Evaluation of Comparability Between Reaches and Locations with the Composite Reference	29
4 Benthic Community Assessment Results	30
4.1 Metric Results By Reach and Location	30
4.1.1 Observations Regarding EPA Metric Results by Reach	31
4.1.2 Observations Regarding EPA Metric Results by Location	34
4.2 Multi-Metric Scoring Results and Biological Condition Statements	34
4.2.1 Observations Regarding EPA Biological Condition Results for Reaches	35
4.2.2 Observations Regarding DNRE Biological Condition Results for Reaches	35
4.2.3 Observations Regarding EPA Biological Condition Results for Locations	36
5 Summary and Conclusions	37
6 References	40

List of Figures

- Figure 1-1: Benthic Community Assessment Methods and Sediment Quality Triad
- Figure 2-1a: Tittabawassee River Segments and Surrounding Areas
- Figure 2-1b: Overview of Sampling Stations
- Figure 2-2: Benthic Community Sample Collection Equipment
- Figure 2-3a: Reference Sample Stations: Chippewa River
- Figure 2-3b: Reference Sample Stations: Tittabawassee River
- Figure 2-3c: Reference Sample Stations: Reach A/B
- Figure 2-3d: Benthic Sampling Stations: Reach E
- Figure 2-3e: Benthic Sampling Stations: Reach F
- Figure 2-3f: Benthic Sampling Stations: Reach G
- Figure 2-3g: Benthic Sampling Stations: Reach H
- Figure 2-3h: Benthic Sampling Stations: Reach I
- Figure 2-3i: Benthic Sampling Stations: Reach K
- Figure 2-3j: Benthic Sampling Stations: Reach M
- Figure 3-1: Ecoregions of the Conterminous United States: Michigan
- Figure 4-1a: Reach Metric Results: Taxa Richness
- Figure 4-1b: Reach Metric Results: Total Number of Mayfly Taxa
- Figure 4-1c: Reach Metric Results: Total Number of Stonefly Taxa
- Figure 4-1d: Reach Metric Results: Total Number of Caddisfly Taxa
- Figure 4-1e: Reach Metric Results: Percent Mayfly Composition
- Figure 4-1f: Reach Metric Results: Percent Caddisfly Composition
- Figure 4-1g: Reach Metric Results: Percent Isopods, Snails, and Leeches
- Figure 4-1h: Reach Metric Results: Percent Dominant Taxon
- Figure 4-1i: Reach Metric Results: Percent Surface Dependent
- Figure 4-1j: Reach Metric Results: Hilsenhoff Biotic Index
- Figure 4-1k: Reach Metric Results: Percent Filterers
- Figure 4-1l: Reach Metric Results: Abundance
- Figure 4-2a: Location-Specific Metric Results: Taxa Richness
- Figure 4-2b: Location-Specific Metric Results: Total Number of Mayfly Taxa
- Figure 4-2c: Location-Specific Metric Results: Total Number of Stonefly Taxa
- Figure 4-2d: Location-Specific Metric Results: Total Number of Caddisfly Taxa
- Figure 4-2e: Location-Specific Metric Results: Percent Mayfly Composition
- Figure 4-2f: Location-Specific Metric Results: Percent Caddisfly Composition
- Figure 4-2g: Location-Specific Metric Results: Percent Isopods, Snails, and Leeches
- Figure 4-2h: Location-Specific Metric Results: Percent Dominant Taxon

- Figure 4-2i: Location-Specific Metric Results: Percent Surface Dependent
- Figure 4-2j: Location-Specific Metric Results: Hilsenhoff Biotic Index
- Figure 4-2k: Location-Specific Metric Results: Percent Filterers
- Figure 4-2l: Location-Specific Metric Results: Abundance
- Figure 4-3a: EPA Multi-Metric Scoring for Grab Compared to Composite Reference: Reaches
- Figure 4-3b: EPA Biological Condition Status for Grab Samples: Reaches
- Figure 4-4a: EPA Multi-Metric Scoring for Hester Dendy Compared to Composite Reference: Reaches
- Figure 4-4b: EPA Biological Condition Status for Hester Dendy Samples: Reaches
- Figure 4-5a: EPA Multi-Metric Scoring for Sweeps Compared to Composite Reference: Reaches
- Figure 4-5b: EPA Biological Condition Status for Sweep Samples: Reaches
- Figure 4-6a: DNRE Multi-Metric Scoring for Sweeps Compared to the Ecoregional Reference: Reaches
- Figure 4-6b: DNRE Biological Condition Status for Sweep Samples: Reaches
- Figure 4-7a: EPA Multi-Metric Scoring for Grabs Compared to Composite Reference: Location-Specific
- Figure 4-7b: EPA Biological Condition and Habitat Score for Grab Samples: Location-Specific
- Figure 4-8a: EPA Multi-Metric Scoring for Hester Dendy Compared to Composite Reference: Location-Specific
- Figure 4-8b: EPA Biological Condition and Habitat Score for Hester Dendy Samples: Location-Specific
- Figure 4-9a: EPA Multi-Metric Scoring for Sweeps Compared to Composite Reference: Location-Specific
- Figure 4-9b: EPA Biological Condition and Habitat Score for Sweep Samples: Location-Specific
- Figure 5-1: Macroinvertebrate Community Quality Ratings for Wadeable and Non-Wadeable Streams – Saginaw Bay Basin
- Figure 5-2: Relationship between Habitat Quality and Macroinvertebrate Community Quality in Wadeable Streams, Saginaw Bay Basin

List of Tables

- Table 2-1a: Summary of Benthic Community Assessment Samples Collected, Sample Locations, and Dates Sampled
- Table 2-1b: Summary of Hester Dendy Deployment and Retrieval
- Table 2-2a: Habitat Scoring Criteria for Wadeable Streams
- Table 2-2b: Habitat Assessment Scores for Benthic Community Locations
- Table 2-3: Sediment Substrate for Benthic Community Locations (Observational Survey)
- Table 2-4a: Summary of Grain Size Distribution
- Table 2-4b: Summary of Total Organic Carbon Concentrations and Moisture Content
- Table 2-5: Water Quality Measurements for Benthic Community Locations
- Table 2-6: Sweep Habitat Characteristic Composition
- Table 3-1: Metric Calculations for Benthic Community Assessment: EPA and DNRE
- Table 3-2: EPA Benthic Macroinvertebrate Scoring Criteria

Table 3-3: DNRE Procedure 51 Macroinvertebrate Metric Scoring and Interpretation: Ecoregion HELP

Table 4-1a: Summary of Metric Results for Grab Samples

Table 4-1b: Summary of EPA Metric Results for Hester Dendy Samples

Table 4-1c: Summary of EPA/DNRE Metric Results for Sweep Samples

Table 4-2a: Dominant Taxon from Grab Samples

Table 4-2b: Dominant Taxon from Hester Dendy Samples

Table 4-2c: Dominant Taxon from Sweep Samples

Table 4-3a: EPA Multi-Metric Scoring for Grab Samples Compared to the Composite Reference: Reach and Locations

Table 4-3b: Summary of EPA Biological Condition Scores for Grab Samples: Reach and Locations

Table 4-4a: EPA Multi-Metric Scoring for Hester Dendy Samples Compared to the Composite Reference: Reach and Locations

Table 4-4b: Summary of EPA Biological Condition Scores for Hester Dendy Samples: Reach and Locations

Table 4-5a: EPA Multi-Metric Scoring for Sweep Samples Compared to the Composite Reference: Reach and Locations

Table 4-5b: Summary of EPA Biological Condition Scores for Sweep Samples: Reach and Locations

Table 4-6a: DNRE Multi-Metric Scoring for Sweep Samples Compared to the Michigan Ecoregional Reference: Reach and Locations

Table 4-6b: Summary of DNRE Biological Condition Scores for Sweep Samples: Reach and Locations

Table 5-1: Overall Summary of EPA and DNRE Biological Condition Scores for the Reaches

List of Appendices

Appendix A: Photo Log

Appendix B: DEQ 2008 Habitat Scoring Excerpts

Appendix C: Benthic Invertebrate Community Data – Grab Samples

Appendix D: Benthic Invertebrate Community Data – Hester Dendy

Appendix E1: Benthic Invertebrate Community Data – Sweeps (EPA)

Appendix E2: Benthic Invertebrate Community Data – Sweeps (DNRE)

Appendix F: Statistical Analysis Output for Reaches

Appendix G: Statistical Analysis Output for Locations

Acronyms and Abbreviations

ANOVA	Analysis of Variance
cm	Centimeters
CR-Ref	Chippewa River Reference
DEQ	Michigan Department of Environmental Quality
DNRE	Michigan Department of Natural Resources and Environment
DO	Dissolved Oxygen
EPA	United State Environmental Protection Agency
ft/s	Feet per Second
GLEAS	Great Lakes and Environmental Assessment Section
HBI	Hilsenhoff Biotic Index
HD	Hester Dendy
HELP	Huron/Erie Lake Plain
km	Kilometers
km ²	Square Kilometers
m ²	Square Meters
MAD	Mean Annual Discharge
m ³ /s	Cubic Meters per Second
mg/kg	Milligrams per Kilogram
µm	Micrometers
MiOps	Michigan Operations
NWHI	Non-Wadeable Habitat Index
ORP	Oxygen Reduction Potential
OU	Operable Unit
RBP	Rapid Bioassessment Protocols
SMA	Sediment Management Area
SQT	Sediment Quality Triad
TOC	Total Organic Carbon
TR-Ref	Tittabawassee River Reference

Executive Summary

The Dow Chemical Company, Inc. (Dow) initiated a *Benthic Community Study* in 2010 as part of investigation activities related to the Tittabawassee River within Operable Unit 1 (OU1), Segments 1 and 2¹. The goal of the benthic community study was to implement standardized and accepted sampling and analysis methods to evaluate the structure/condition of the benthic macroinvertebrate community (i.e., the sediment dwelling organisms) in the Tittabawassee River in the vicinity of The Dow Chemical Company Michigan Operations Facility (MiOps) in Midland, MI.

The benthic community assessment study involved:

- Sampling 21 locations from 9 Reaches including reference stations located in the upstream Tittabawassee River, upstream Chippewa River, and below the Tittabawassee/Chippewa confluence and upstream from Dow's MiOps facility.
- Collecting and analyzing data from 167 discrete benthic community samples using three sampling methods, each providing unique insight into the benthic community.
- A systematic evaluation of river habitat characteristics, water quality measurements, and sediment substrate characteristics.
- Detailed reporting of activities and methods used to conduct the study including the use of United States Environmental Protection Agency (EPA) and Michigan Department of Natural Resources and Environment (DNRE) quantitative evaluation approaches.
- Data grouping in a manner that provided an understanding of benthic community condition for "Reaches" as defined for OU1 and each individual location, including those that were sampled within Segment 1 sediment management areas (SMAs), as defined in the Segment 1 Response Proposal.
- An analysis and comparison of results from locations downstream from Dow's MiOps facility to upstream reference locations and to DNRE's designated eco-regional reference.

The benthic community study results showed that:

- Benthic communities adjacent to and downstream from Dow's MiOps facility (down to Reach M) were robust (diverse, abundant) and not significantly different from reference conditions when considered for overall Reaches, with the following conclusions drawn based on EPA and DNRE scoring criteria and condition designations:
 - Conditions in Reaches E through M, when compared to the DNRE ecoregional reference approach scored from "excellent" to "*tending toward excellent*."
 - Conditions in Reaches E through M, when compared to reference areas using the EPA approach scored from "*non-impaired*" to "*slightly impaired*," depending on the Reach and sampling type.

¹ The majority of sampling was conducted in Segment 1. Several Reaches within Segment 2 were also included in the Study (Reaches I, K, and M).

- Statistical testing on a Reach basis did not identify any significant differences between reference conditions and benthic community structure in Reaches E through M.
- Benthic community results were also considered for each sampling location within Reaches, including those within areas designated as Segment 1 SMAs. These results also indicated that for most locations, benthic community conditions were similar to that found at reference locations. Two locations were identified with benthic community conditions that were statistically significantly different from that observed at reference locations, and these results suggest potential localized effects of chemical contaminants and/or stormwater sources as follows:
 - One station in Reach H (RH-150+00) located within SMA 6 with elevated concentrations of ethyl parathion.
 - One station in Reach I (RI-164+50) that had one of the lowest habitat characterization scores, and a benthic community represented by proportionally more pollution-tolerant species. This location exhibited slightly higher scores for the Hilsenhoff Biotic Index (HBI), suggesting potential organic (i.e., nutrient) enrichment sources attributable to regional stormwater inputs from Lingle Drain, which discharges to the Tittabawassee River immediately upstream of this station.
- Benthic community structure/condition at locations sampled in the Tittabawassee and Chippewa Rivers is generally within the range of conditions observed in other similar-sized Michigan rivers.

In summary, this benthic community assessment study was successfully implemented, produced a technically strong and useful dataset, and numerous lessons were learned. The study sampling methodologies worked well. A wide range of habitat conditions were encountered and sampled. Suitable reference areas were identified, and the Composite Reference approach was shown to be a robust way to integrate results from numerous reference locations. While the results of this benthic community study are robust, it is recognized that this assessment was only one sampling effort. The data collected during the benthic community study support the conclusion that the benthic community in Reaches E through M is diverse, abundant, and comparable to Composite Reference locations with two exceptions (as noted above for specific localized areas within Reaches H and I, which may be potentially related to an unidentified SMA or ongoing stormwater discharges). Benthic community structure/condition at most locations was very comparable to (not different from) the Composite Reference conditions, even in most samples collected from within Segment 1 SMAs. Sampling results and observations from this benthic community study suggest that non-chemical habitat limitations (i.e., relative lack of structure and coarse particulate organic matter) influence the benthic community in Segments 1 and 2. In conclusion, results from this benthic community study indicate that the structure/condition of benthic communities within Segments 1 and 2 of the Tittabawassee River (down to Reach M) is comparatively similar to that observed at site-specific reference stations, as reflected by the Composite Reference, and consistent with eco-regional reference conditions.

1 Introduction

The Dow Chemical Company, Inc. (Dow) initiated a benthic community study during 2010 as part of investigation activities related to the Tittabawassee River within Operable Unit 1 (OU1), Segments 1 and 2². This report provides a detailed description of this benthic community study, including the purpose and objectives of the study, review of technical guidance and methods used to implement the work, and the findings of the study.

1.1 Benthic Community Study Objectives

The purpose of the 2010 benthic community study was to implement standardized and accepted sampling and analysis methods to evaluate the condition of the benthic macroinvertebrate community in the Tittabawassee River in the vicinity of The Dow Chemical Company Michigan Operations Facility (MiOps) in Midland, Michigan. This benthic community study was designed and intended to provide an approach for the evaluation of potential risks from sediment-associated contaminants to benthic receptors (populations and communities) in Segments 1 and 2, supplementing other approaches including sediment chemistry and toxicology available for these reaches of the river into an overall sediment quality triad (SQT) approach (Figure 1-1). In addition, samples were located in identified Segment 1 sediment management areas (SMAs), but it was not the goal of the study to exclusively characterize those SMAs. As such, benthic community locations were not specifically co-located with chemistry or toxicity testing locations. SMAs, and the basis of the SMAs, are provided in the Segment 1 Response Proposal (Dow 2011).

In order to evaluate the condition of the benthic community and further inform identification of appropriate Segment 1 response actions, the following were the overall objectives of the 2010 benthic community study:

- Conduct an objective evaluation of the benthic community in the Tittabawassee River using standard United States Environmental Protection Agency (EPA), Michigan Department of Natural Resources and Environment (DNRE; and former Michigan Department of Environmental Quality [DEQ]) sampling methods, assessment protocols, and analysis procedures
- Provide an approach for evaluating the condition of the benthic macroinvertebrate community in the river, including, but not limited to SMAs identified within Segment 1
- Evaluate spatial trends in the condition of the benthic community (i.e., community structure) for locations adjacent to and downstream from Dow's MiOps facility, comparing benthic community conditions in Segment 1 with site-specific and eco-regional reference conditions

² The majority of sampling was conducted in Segment 1. Several Reaches within Segment 2 were also included in the Study (Reaches I, K, and M).

- Consider the benthic community data in the general context of a SQT approach, recognizing the distinction between the available data (limited corresponding station-specific data for sediment chemistry, toxicity and benthic community structure) and a formal SQT
- Assess the importance of potential relationships between community structure metrics, habitat factors, and chemical stressors
- Compare results from the 2010 benthic community study with results obtained by other investigators for other similar rivers in Michigan (Goodwin 2008), to the extent that such information is available
- Use experience and information gained during the study to inform future benthic community studies, if such studies are deemed necessary

1.2 Technical Guidance

The 2010 benthic study was conducted using EPA and DNRE sampling methods, assessment protocols, and analysis procedures (EPA 1989, 1999, 2002, 2006, DEQ/Creel et al. 1998, Wilhelm et al. 2005, DEQ³ 2008). Both wadeable and non-wadeable assessment approaches were considered because both types of habitats are present in the Tittabawassee River and it was unclear at the onset of the study which approach would be most effective (i.e., considering accessibility). According to DEQ (2008), the physical transition between wadeable and non-wadeable rivers is not distinct and is primarily determined by the ability to adequately sample all available habitats and safely wade the majority of the channel. It is generally preferable to sample the benthic community using wadeable techniques, especially where hard-bottom substrates exist, because wading enables the use of certain sampling methods that more effectively allow diverse habitats to be sampled quantitatively. For example, collection of a benthic grab sample using a Surber sampler⁴, which is used in wadeable conditions, allows sampling in crevice habitats (e.g., between rocks) that many organisms prefer. Sampling in these habitats is nearly impossible using a standard non-wadeable dredge sampling technique because the cobble and gravel material in the streambed prevent the proper closure of a dredge.

Designation between wadeable and non-wadeable conditions was challenged by the daily variability of the surface water elevations due to the release of water from the Sanford Dam. For example, no water is released on weekends, so some areas of the Tittabawassee River were wadeable on the weekend through mid-morning on Monday, but those same areas were not safely wadeable Monday afternoon through Friday afternoon. The following guidance documents were considered for use in the benthic community study:

³ References to DEQ guidance is provided for accuracy in a manner consistent with DNRE posting of guidance documents on the DNRE website (e.g., "Procedure 51" guidance is posted on the DNRE website under the title "*DEQ Water Bureau Policy and Procedures*").

⁴ This sampling technique is described in detail in Section 2.4.1.

- Habitat assessment of non-wadeable rivers
 - Concepts and Approaches for the Bioassessment of Non-wadeable Streams and Rivers (EPA 2006)
 - Habitat Assessment of Non-Wadeable Rivers in Michigan (Wilhelm et al. 2005)
- Benthic invertebrate community assessment for wadeable rivers
 - Rapid Bioassessment Protocols (RBP) for use in Streams and Wadeable Rivers (EPA 1989, 1999)
 - Qualitative Biological and Habitat Survey Protocols for Wadeable Streams and Rivers (DEQ 2008)
 - Great Lakes and Environmental Assessment Section (GLEAS) Procedure 51 Metric Scoring and Interpretation (DEQ/Creel et al. 1998)

The primary objective of the benthic community study was to provide an approach for evaluating the condition of the benthic community in the Tittabawassee River. By using sampling and analysis techniques developed by EPA and DNRE, this benthic community study was designed to provide data for assessing potential spatial trends (i.e., differences) in benthic community structure.

As noted above, sampling locations included stations within Segment 1 SMAs to the extent that those areas were accessible for benthic sampling. As such, results from this work reflect benthic community conditions within the Segment 1 SMAs; but it was not the goal of this study to comprehensively characterize these SMAs. Finally, data from this benthic community study are useful as part of a SQT-type approach, recognizing the distinction/difference between the benthic community study performed in Segment 1 and that which would be done to support a more formal SQT (Figure 1-1). A formal SQT involves more extensive co-located sampling to compare and integrate multiple approaches related to sediment chemistry, toxicology, and biological community assessment (EPA 2002). In fact, some Tittabawassee River locations where sediment samples were collected earlier (e.g., in 2008 and 2009) have already been remediated. In this study, benthic community assessment sampling stations were not specifically and fully co-located with those for sediment chemistry and toxicity testing. Thus, the data can and should be considered collectively in the spirit or context of an appropriate SQT-type approach.

Notwithstanding this lack of overlap, this report provides an SQT-type evaluation by providing data that:

- Directly measure benthic community structure in the river, with data grouped into Reaches consistent with the upper OU1 “Reach” designations that have been developed for the river investigation
- Include location-specific analysis and discussion of results so that samples placed within areas designated as SMAs within the Segment 1 Response Proposal can be examined

1.3 Reference Site Approach

An important component of any benthic community assessment is the comparison to reference sites or conditions, since this is the basis for determining whether or not impairment is observed (EPA 1999, 2006, DEQ 2008, DEQ/Creel et al. 1998). The 2010 benthic community study evaluated multiple site-specific reference areas in the Tittabawassee River, the Chippewa River, and at the confluence of the Tittabawassee and Chippewa Rivers upstream/upgradient from Dow's MiOps facility. The identification and designation of site-specific references follows EPA guidance (1989, 1999, 2006). In addition to evaluation of site-specific reference conditions, this report also compares the 2010 benthic community study results to an "eco-regional reference" within the State of Michigan, as identified in DNRE guidance (DEQ 2008, DEQ/Creel et al. 1998). These approaches are described in detail in Section 2 of this report.

1.4 Report Organization

The remainder of this report is as follows:

- Section 2 describes sampling locations, habitat assessment approach, and rationales for the selected approaches.
- Section 3 identifies the benthic community assessment methodology, data analysis approach, including the taxonomic identification protocols and the benthic community metric calculation approach using both EPA and DNRE data analysis techniques.
- Section 4 presents the habitat assessment results critical to understanding the comparability of habitats between locations and the site-specific reference areas. In addition, Section 4 provides the benthic community assessment results for three types of sampling methods, showing both Reach-based average results and location-specific results to provide insight into potential influences from SMAs.
- Section 5 summarizes the results for the 2010 benthic community study by discussing how results for locations adjacent to and downstream from Dow's MiOps facility compare to site-specific reference areas. The 2010 results are also evaluated and discussed in the context of DNRE's eco-regional reference approach, based on previous studies of similar rivers in Michigan. Finally, Section 5 reflects on the implementation of the standard EPA and DNRE methods used in this study and discusses lessons learned.

2 Benthic Habitat Assessment Methods and Results

The benthic community assessment sampling was comprised of two key components: 1) the habitat assessment and 2) the collection of benthic macroinvertebrates. This section identifies:

- The sampling locations included for habitat and benthic community assessment, including the rationale for sample location selection (including site-specific reference stations), and the proximity of sampling locations to SMAs.
- The habitat assessment field documentation, including the DNRE-based scoring approach and the additional water quality parameters sampled during the field effort.

2.1 Sampling Locations

The 2010 benthic community study was conducted in the area of the Tittabawassee River identified as OU1, with sampling focused on the upstream reaches of OU1 within Segment 1 and a small portion of Segment 2 (Figures 2-1a and 2-1b). The selection of sample locations was based on a two-tiered approach considering: (1) location relative to the Dow MiOps facility; and (2) the availability of comparable benthic community habitat within different Reaches and at site-specific reference stations.

- The rationale included consideration of site-specific reference stations and Reach-based locations adjacent to and downstream from the MiOps facility. Site-specific reference stations included upstream Tittabawassee River sites, upstream Chippewa River sites, and a reference area between the confluence of these rivers and the MiOps facility (Reaches A and B of Segment 1).
- The habitats at each location were carefully inspected and efforts were made to identify consistent and comparable habitats to the extent such habitats were present. This is important because differences in habitat can lead to differences in community structure. Controlling for habitat, to the extent possible, allows for more direct comparisons of benthic communities among locations. Habitat scoring methods were used as part of this inspection process, and this approach is described further below.

Reaches within Segment 1 and 2 adjacent to and downstream from the Dow MiOps facility included:

- Reach E
- Reach F
- Reach G
- Reach H
- Reach I
- Reach K
- Reach M

As mentioned above, three site-specific reference areas were sampled upstream of the Dow MiOps facility in the Tittabawassee River and Chippewa River. Samples collected within Reaches A and B reflect reference conditions within the river where the Tittabawassee and Chippewa Rivers begin to mix across the channel. The benthic samples collected within Reach B were located close to the Reach A/B boundary (i.e., only a short distance into Reach B). Since the samples from Reaches A and B were collected to reflect reference conditions in the tributary mixing zone, they were combined to reflect the Reach-specific conditions of this portion of the river (and are considered separately for discussions of location-specific results). These reference areas are designated as follows:

- Reaches A/B
- Tittabawassee River Reference
- Chippewa River Reference

Figure 2-1b provides an overview of the sampling locations within Segment 1 and Segment 2 of the Tittabawassee River and reference locations within the Tittabawassee and Chippewa Rivers. Each sampling type is described in Figure 2-2. Detailed mapping of sample locations are presented in Figures 2-3a through 2-3j. A photo log of sample locations and field efforts is provided in Appendix A.

Table 2-1a presents information on the types of samples collected (grab, sweep, total organic carbon [TOC]/grain size, habitat assessment, water quality, and flow), sample locations, and the dates the samples were collected. Similar information is presented in Table 2-1b for the artificial substrate samples (HDs), including information on deployment and retrieval.

2.2 Habitat Assessment Approach and Results

A habitat assessment is an important component of the benthic community assessment because habitat quality directly influences the benthic community abundance and diversity. Therefore a semi-quantitative evaluation of habitat conditions allows insight into the benthic community that may be present at any location and provides a basis for comparison between locations of interest in Segments 1 and 2 and the reference areas. Habitat assessment field documentation followed EPA and DNRE guidance (EPA 2006, Wilhelm et al. 2005, DEQ 2008). For consistency, one qualified person was designated to score all locations.

Wadeable and non-wadeable guidance was considered because portions of the river fall into both categories and initially, it was not considered likely that sufficient wadeable habitat would be available at all locations. Wilhelm et al. (2005) define non-wadeable rivers in Michigan as those that (1) equal or exceed a river order of five; have a drainage area of at least 1,600 square kilometers (km²); (3) have a main-stem length of at least 100 kilometers (km); and (4) have a mean annual discharge (MAD) of at least 15 cubic meters per second (m³/s). Using these criteria, the Tittabawassee River is identified as a non-wadeable river (river order of 6, drainage area of 6,853 km², main-stem length of 343 km, MAD of 49 m³/s) (Wilhelm et al. 2005). Therefore, DNRE's Non-Wadeable Habitat Index (NWHI; Wilhelm et al. 2005) was

initially considered the most likely approach that should be used to characterize habitat in the Tittabawassee River and reference areas. During the study, additional opportunities to collect wadeable samples were recognized, in part because of daily fluctuations in discharge from the upstream Sanford Dam. Therefore, the DNRE wadeable habitat scoring approach was ultimately used for this assessment (DEQ 2008). The DNRE wadeable habitat scoring is consistent with EPA's habitat scoring of wadeable habitat. An overview of the scoring approach is provided in Table 2-2a, and the habitat scoring is provided in Table 2-2b. Excerpts from the DNRE guidance related to the elements of habitat scoring are provided in Appendix B.

Scoring addresses three key categories of habitat structure:

- Substrate and instream cover
- Channel morphology
- Riparian and bank structure

There are 10 habitat variables that fit within the 3 categories of habitat structure. Each variable is scored on a scale of 1 to 20, for a total of up to 200 points that are used to designate habitat quality as poor (score 0 to 50), marginal (score 51 to 100), good (score 101 to 150), and excellent (score 151 to 200). Habitat scoring for each of the sample locations included in the benthic study, including the overall ranking of poor to excellent, are provided in Table 2-2b. The two Tittabawassee reference areas scored in the excellent range. The majority of locations scored in the good range. Five locations scored in the marginal range. Every effort was made to select locations as comparable as possible; nonetheless, as seen in Table 2-2b, there were differences among locations. The contribution of habitat differences as explanations for differences in community composition and structure is discussed further in Sections 4 and 5.

2.3 Sediment Characteristics and Water Quality Related to Habitat Assessment

General sediment and water quality assessments are also components of habitat characterization, as non-chemical factors including sediment grain size, TOC content, and dissolved oxygen (DO) can have a significant influence on community structure. Therefore, in addition to the seven metrics required by the NWHI, additional habitat characterization data were collected at each reach. Table 2-3 presents the approximate proportions of sediment substrate that were boulders, cobbles, gravel, sand, silt, or clay⁵. The categories were estimated based on visual inspection of the sediment surface where benthic grab samples were collected. Results showed consistently larger substrate size in the Tittabawassee River locations and much smaller substrate sizes in the Chippewa. Segment 1 and 2 locations fell within this overall range.

⁵ Substrate size classes are defined as particles with the following diameters: boulders (greater than 256 millimeter [mm]), cobbles (64 mm to 256 mm), gravel (2 mm to 64 mm), sand (1/16th mm to 2 mm), silt (1/256th mm to 1/16th mm), and clay (less than 1/256th mm).

Sediment samples were also collected and analyzed for grain size and TOC. These data are provided in Table 2-4a and 2-4b.

- Grain size results showed comparable substrates among most locations. Reaches RE-62, RH-143, and RM-285 having generally the larger grain size and RA-Ref 01, RB-13, RE-77+50, and RI-166 having among the smallest grain size.
- TOC results ranged from non-detect (Reach B) to 2.5% (Reach I). The Tittabawassee River locations generally averaged 1% to 1.2% TOC while the Chippewa and Reaches A and B had less than 0.5% TOC at each location. As discussed in more detail below, these substrate differences may influence benthic community characteristics between the different reference locations.

The final component of the habitat assessment effort included as part of the benthic study was the collection of water quality parameters. Table 2-5 presents results for the following water quality parameters measured in each reach:

- Flow rate
- Salinity
- Dissolved oxygen
- Oxidation reduction potential (ORP)
- Temperature
- Specific conductance
- pH
- Turbidity

The results from the water quality assessment showed that with limited exceptions, the locations sampled had comparable water quality conditions. There were some differences in river velocity, but that was also influenced by timing of measurement with regard to releases from the Sanford Dam. For example, TR-Ref-01 was sampled prior to water release from the dam (measured velocity of 0.31 feet per second [ft/s]). However, Ref-02, located only a short distance away, was measured during the water release period (velocity of 1.53 ft/sec). DO levels were near (or above) saturation throughout the Tittabawassee River, indicating productive photosynthetic communities (e.g., by suspended and/or attached algae). The pH measurements were also similar between all stations, with values ranging from 8.68 to 9.63, which also indicate productive photosynthetic communities.

3 Benthic Community Sampling Methods and Data Analysis Approach

Three benthic macroinvertebrate sample collection techniques were used during the benthic community study. This section describes the technique and how each technique provides different views of the benthic community in the river.

3.1 Benthic Community Assessment

EPA and DNRE identify multiple benthic community assessment sampling procedures and all have different utilities. It is often advantageous to use multiple approaches for the purpose of adequately characterizing the benthic macroinvertebrate community. Therefore, collection of benthic macroinvertebrates was conducted using three types of sampling collection: benthic grab samples (grab samples), artificial substrate samples (Hester Dendy [HD] samples), and qualitative, multi-habitat samples (sweep samples). These are described in more detail below and illustrated on Figure 2-2. Sample handling and shipment is also briefly described.

3.1.1 Benthic Grab Samples

Benthic grab sampling provides a focus on river sediments. The type of grab sampler used depends on whether the habitat is considered wadeable or non-wadeable and on what type of sediment substrate and grain size is found during the benthic community assessment. Relatively fine grained silt and sand substrates are typically best sampled using a grab sampler such as a petite ponar, whereas coarser grain sediment, such as gravel and cobble, are often best sampled using a Surber sampler. The substrates from the sampling locations were comprised primarily of sand, cobble, and rocky substrates and have relatively coarse grain sizes (Tables 2-3). Therefore, given the presence of cobble substrates and wadeable habitat, the Surber grab method was determined to be the most suitable sampling method.

Surber grab samplers collect organisms from flowing water passing through the sampler (EPA 1990, 2006) and consist of two frames hinged together (one frame rests on the substrate and the other remains upright to hold the nylon collection net). To collect organisms, the Surber was positioned with the net mouth facing upstream. Substrate upstream of the sampler was disturbed to a depth of approximately 10 centimeters (cm). Large stones and woody debris were carefully rubbed to remove organisms and allowed to flow in to the sampler. Once the sampler was removed from the water, the sample was rinsed into a sorting tray and sieved to remove water (EPA 1990).

Grab samples were obtained from 19 locations within Segment 1 and Segment 2, as well as within the Tittabawassee and Chippewa River reference areas (i.e., 13 locations adjacent to and downstream from Dow's MiOps facility, and 6 locations within the 3 reference areas, including those from Reaches A/B). Three replicate grab samples were collected at each sampling location, resulting in 57 discrete grab samples (Table 2-1a, and Figures 2-3a through 2-3j).

3.1.2 Artificial Substrate Samples

The use of artificial substrate samplers augments the benthic grab sampling approach because it allows consideration of organisms that reside within the river but that have habitat preferences not readily sampled using benthic grab approaches (e.g., those requiring larger grain/cobble substrates or those that inhabit woody debris). The artificial substrate sampling approach can provide insight on potential benthic community gradients within the river (if any), as this approach standardizes the habitat structure at each location. As discussed above, sediment physical characteristics can interfere with the ability to interpret benthic macroinvertebrate data.

HD artificial substrate samplers are among the most common artificial substrates available and they come in a variety of shapes and sizes. Figure 2-2 shows an example HD sampler. The HD samplers used in this benthic community assessment consisted of a series of 14 round hardboard plates, separated by spacers and fastened together through their centers to a threaded eyebolt. The hardboard sampler was approximately 14 cm long and had a surface area of roughly 0.116 square meters (m²). Photographs of HD samplers used in the study are provided in the Photo Log in Appendix A. The HD samplers were attached to a rope which was weighted with a cinderblock anchor and a buoy to keep the sampler off the river bottom. During HD sampler recovery, a 500 micrometer (µm) mesh net was held just downstream of the sampler in order to recover dislodged organisms (EPA 1999).

The HD samplers were deployed at 21 locations within Segment 1 and 2, as well as within the Tittabawassee River and Chippewa River reference areas. The HDs were deployed for a period of 28 days to allow for colonization of benthic macroinvertebrates (Table 2-1b, and Figures 2-3a through 2-3j). Deployment and retrieval dates are identified on Table 2-1b. Five replicates were placed at each location, resulting in 105 discrete samplers being deployed. Nine HD samplers were not recovered due to high flow conditions and debris. Therefore, 96 discrete samples were collected. The following HD samplers were not recovered:

- Two HD samplers from Reach E (RE-073+00)
- Two HD samplers from Reach H (RH-143+00)
- Five HD samplers from Reach F (RF-108+50)

3.1.3 Sweep Samples

The sweep sampling technique enables characterization of habitats within the river that are not captured by either grab samples or artificial substrates. These include vegetated margins, undercut banks, large woody debris, and other habitats where benthic organisms dwell. Sweep sampling followed procedures outlined in DEQ (2008). Macroinvertebrate samples were collected from all available habitats either by using a dip net or by hand picking. Each sweep sample collected from individual locations was combined to form one composite sample for that station. Approximately 20 minutes of sampling time was spent per location to ensure adequate sampling of all habitat types. The composition of sweeps included six subsamples that represented the overall habitat available at each location, as recorded for each location in Table 2-6. Example sweep subsamples included the following:

- Woody debris sweep
- Submerged aquatic vegetation sweep
- Leaf pack sweep
- Gravel bottom sweep
- Cobble bottom sweep
- Algae covered boulder sweep
- Vegetated gravel sweep

Sweep samples were collected from 14 locations within Segment 1 and Segment 2 and the Tittabawassee and Chippewa River reference locations. One composite sample was collected at each location, resulting in 14 discrete samples (Table 2-1a, and Figures 2-3a through 2-3j).

3.1.4 Sample Handling and Shipment

A total of 167 discrete samples were collected, placed in individual containers, preserved in 70% isopropyl alcohol, and shipped with appropriate dangerous goods packaging/labels to a qualified laboratory for taxonomic identification. Taxonomic identification is discussed further in Section 3.

3.2 Data Analysis

The benthic community data analysis involved four comprehensive steps, each described in detail in this section:

- 1 Taxonomic identification of the organisms within each sample replicate to the lowest taxonomic level practical
- 2 Calculation of 12 “metrics”
- 3 “Multi-metric scoring” using the EPA approach to yield statements of “biological condition”
- 4 Multi-metric scoring using the DNRE approach to yield statements of biological condition

A benthic community metric is a quantitative indicator of an attribute of the biological community. Each metric can be considered a separate approach. Each metric provides a unique attribute of the biological community. Alone, they provide focused insight into a particular part of the community balance, and collectively, the multiple metrics provide a broad understanding of the benthic community as a whole. There are 12 metrics considered, as described in detail below.

The multi-metric scoring approach is a systematic and straightforward mathematical approach where each metric from each location is given a score based on how it compares to either the site-specific reference (EPA) or the ecoregional reference (DNRE).

Statements of biological condition are qualitative summary descriptions based on the similarity between any given location and the site-specific reference or ecoregional reference. Biological condition is defined by EPA and DNRE using different terminology, as follows:

- Locations are designated as non-impaired, slightly impaired, moderately impaired, or severely impaired using the EPA approach. For example, when a location is within approximately 20% of the site-specific reference location, then the location is considered non-impaired.
- Locations are designated as being excellent, tending toward excellent, neutral, tending toward poor, or poor using the DNRE approach based on how the combination of nine metrics compared to the reference metrics. For example, when a location is given a score of +5 to +9, then the location is considered excellent.

The methods for scoring are conceptually the same for both the EPA and the DNRE approaches, the key differences (other than terminology) are as follows:

- The EPA allows selection from 30 to 40 metrics, and those identified for use in this study are consistent with those identified by DNRE as being the most appropriate for use in Michigan (EPA 1989, 1999; DEQ 2008, Creek et al. 1998). The EPA approach includes two additional metrics not considered as part of the DNRE approach. The rationale for those metrics are described further in Section 3.1.1.
- The EPA approach is based on comparisons to site-specific references (i.e., those from the 2010 benthic study, Figure 2-1b) while the DNRE approach is based on a comparison to literature derived regional reference values developed from extensive sampling performed during the mid-1980s (Omernik 1987, illustrated on Figure 3-1).
- The EPA approach applies to all three sampling types (grabs, HDs, and sweeps) but the DNRE approach applies only to sweeps.

The remainder of this section describes each of the four comprehensive steps identified above.

3.3 Taxonomic Analysis

Normandeau Associates, Inc. conducted the taxonomic identification at their laboratory in Stowe, Pennsylvania. Subsampling was conducted for abundant species, and whole sort/counts were performed for non-abundant taxa using EPA protocols (EPA 1999, Normandeau 2010). After all non-abundant taxa were removed from the matrix, a Folsom splitter was used on the remaining matrix to cut it down to 1/2 or 1/4 (sometimes lower for extremely abundant taxa). This split was then completely sorted for the abundant taxa. All individuals were identified and their counts multiplied by the appropriate split ratio. Subsampling in this manner allowed the sorter to look at the whole matrix, so rare taxa were not overlooked, while also maximizing efficiency. Sorted organisms were separated into vials for slide-mounted (chironomids and oligochaetes) and non-mountable fractions. Chironomid larvae and oligochaetes were mounted permanently on microscope slides using CMC-10 mounting media. Identifications were made to the lowest practical taxon. Taxonomic identification results are provided in Appendices C, D, and E for grab samples, HDs, and sweeps, respectively.

3.3.1 Benthic Community Metric Descriptions

Multiple benthic community metrics were calculated for this assessment in accordance with EPA and DNRE guidance (EPA 1998, 1999, 2006⁶, DEQ 2008). Each metric provides an approach to assess the condition of the benthic community. As discussed above, a primary difference between the EPA and DNRE approaches is that the EPA approach uses a scoring approach that is directly tied to matched reference samples collected synoptically.

Tittabawassee River samples were compared to several reference locations within the Chippewa River and the Tittabawassee River upstream of the Dow Dam. Conversely, the DNRE approach compares metric results to an appropriate ecoregional reference site (DEQ 2008) within the Huron/Erie Lake Plains (HELP) ecoregion as described by Omernik (1987, Figure 3-1).

The EPA and DNRE metrics included for the benthic community assessment of the Tittabawassee River and reference areas are summarized in Table 3-1. Table 3-1 also presents the calculational approach for each metric, in accordance with EPA and DNRE methods (EPA 1999, DEQ 2008). The metrics reflect a variety of community characteristics, such as richness (i.e., diversity), community composition, tolerance (i.e., those measures showing a shift toward pollution tolerant species, and functional feeding groups). A brief description of each metric is provided as follows:

Richness Metrics

- 1 **Total Number of Taxa.** The total number of taxa or species found in the sample. Higher species richness values are generally associated with higher water quality and/or habitat conditions. This metric reflects the health of the community by measuring the variety of taxa present.
- 2 **Total Number of Mayfly Taxa.** The total number of taxa in the order Ephemeroptera (mayflies), which are considered pollution sensitive and are an important component of high quality stream biota. Therefore, higher mayfly richness values are generally associated with more favorable habitat and/or environmental conditions.
- 3 **Total Number of Caddisfly Taxa.** The total number of taxa in the order Trichoptera (caddisflies), which like mayflies are considered relatively pollution sensitive, although caddisflies display a wider range of tolerance and habitat selection among species. The main constraints for large populations of caddisflies tend to be optimal habitat and availability of appropriate food types. The number of taxa present can be a good indicator of habitat and/or environmental conditions.
- 4 **Total Number of Stonefly Taxa.** The total number of taxa in the order Plecoptera (stoneflies), which are one of the most pollution sensitive orders of aquatic insects. The

⁶ EPA (2006) recommends the use of the well developed and documented Rapid Bioassessment Protocols (RBP) multi-metric index for biotic condition for benthic macroinvertebrates (EPA 1989, 1999).

presence of one or more taxa is often used to indicate very good habitat and/or environmental quality.

Community Composition Metrics

- 5 **Percent Mayfly Composition.** The ratio of the number of individuals in the order Ephemeroptera to the total number of individuals collected. The percent abundance of mayflies in the sample may change considerably and quickly to minor environmental disturbances.
- 6 **Percent Caddisfly Composition.** The ratio of the number of individuals in the order Trichoptera to the total number of individuals collected. Percent abundance is strongly related to stream size with greater proportions found in large order streams.
- 7 **Percent Isopods, Snails, and Leeches.** The ratio of the sum of the number of individuals in the order Isopoda and classes Gastropoda and Hirudinea to the total number of individuals collected in the sample. When compared as a combined percentage of the invertebrate community, these three groups can give an indication of the degree of environmental disturbance present. Isopods, snails, and leeches, typically show a high tolerance to a variety of physical and chemical parameters and therefore, higher percentages of these organisms are a good indicator of stream degradation (DEQ 2008).

Tolerance Metrics

- 8 **Percent Contribution of the Dominant Taxon.** Dominance is a simple measure of community balance, or evenness, of the distribution of individuals among the species. Simple dominance is the percent contribution of the most numerous species. High dominance values indicate unbalanced communities strongly dominated by one or more numerous species.
- 9 **Percent Surface Dependant.** The ratio of the number of macroinvertebrates that obtain oxygen via direct atmospheric exchange to the total number of individuals collected. These organisms typically obtain oxygen at the air/water interface. A high percentage of “surface breathers” may indicate poor water quality or areas subject to elevated temperatures, or low or erratic flow patterns (DEQ 2008). A list of surface dependent aquatic macroinvertebrates is included in Appendix I of DNRE (2008).
- 10 **Hilsenhoff Biotic Index (HBI).** The HBI produces a numerical value to indicate the level of organic pollution (Hilsenhoff 1982). The HBI is calculated by multiplying the number of individuals of each species by its assigned tolerance value, summing these products, and dividing by the total number of individuals. On a 0 to 10 scale, tolerance values range from intolerant (0) to tolerant (10). Tolerance index values, are mostly from Hilsenhoff (1977, 1982, 1987, and 1998). High HBI values are indicative of potential organic (sewage) pollution.

Functional Feeding Group Metric and Other Relevant Metrics

11 Ratio of Filterers to Total Organisms. The ratio of filterers is a reflection of the functional feeding group balance. Filterers are among several functional feeding groups that might be selected, but this group is least dependent upon specific habitat type, and therefore is the most commonly used. In addition, filterers are sensitive to pollution.

12 Abundance. Abundance is the simple counting of organisms. Greater abundance can mean greater accessibility to a food source or it could mean the presence of high numbers of pollution tolerant organisms. Abundance itself is not “scored” as part of the multi-metric scoring, but it is a component of many of the metrics described above.

3.3.2 Data Organizational Approaches

Two data organizational approaches were used to present individual metric results and for the multi-metric scoring approaches. The benthic community metric data were organized by Reach and also by location. Generally, only one sweep per Reach was collected, so there was little difference between the Reach and location organization of sweep data.

3.3.3 Two EPA and DNRE Multi-Metric Scoring Approaches

Two multi-metric scoring approaches were used in this benthic community study. As described earlier in this section, the EPA approach involves the comparison of benthic community conditions adjacent to and downstream from the MiOps facility to site-specific reference conditions while the DNRE approach involves comparisons to the eco-regional references. The mathematics are similar, but vary as follows:

- The EPA multi-metric index data analysis is performed by calculating a numerical value for each metric based on the raw benthic data. Calculated values are then compared to values derived from the reference areas. Each metric is then assigned a score according to the comparability of calculated versus reference values (EPA 1989, 1999). Scores are totaled and a biological condition category is assigned as described in Table 3-2. The EPA multi-metric approach ends with a statement of biological condition relative to the percent similarity of any location with the site-specific reference dataset. The reference area dataset is referred to as the “Composite Reference” as it is the average of each of the six reference locations included in the 2010 benthic study. Locations are designated as non-impaired, slightly impaired, moderately impaired, or severely impaired based on the percent similarity with the Composite Reference location. For example, when a location is within approximately 20% of the site-specific reference location, the location is considered non-impaired.
- The DNRE macroinvertebrate community multi-metric scoring approach is presented in Table 3-3. The DNRE multi-metric data analysis is performed by calculating a macroinvertebrate score for each sampling location based on the sum of the first nine metrics described above in Section 3.1.1. A scale of +1, 0, -1 is used to score each metric, therefore the scoring ranges from +9 to -9 for the macroinvertebrate community at

a location (Table 3-3). Each metric score for an individual sampling location is compared to the appropriate ecoregional reference site (HELP) (Figure 3-1). A final biosurvey category describing the degree of similarity to the reference site (ranging from excellent to poor) is given to each sampling location based on the total metric score calculated (DEQ 2008, DEQ/Creel et al. 1998). Locations are designated as being excellent, tending toward excellent, neutral, tending toward poor, or poor using the DNRE approach based on how the combination of nine metrics compared to the reference metrics (Table 3-3). For example, when a location is given a score of +5 to +9, then the location is considered excellent.

3.3.4 Statistical Evaluation of Comparability Between Reaches and Locations with the Composite Reference

A statistical analysis was conducted as part of the evaluation of the multi-metric scoring results. Specifically, an analysis of variance (ANOVA) was used to examine statistically significant differences in the benthic community between Reaches or locations and the Composite Reference for grab, HD, and sweep samples. The following testing approach was used:

- SigmaPlot for Windows, Version 11.0, Build 11.2.0.5 (copyright 2008, Systat Software Inc.) was used to run the statistical analysis.
- Prior to starting the ANOVA, a Shapiro-Wilk test was performed on the data to assess the normality of the dataset (p value = 0.05). An Equal Variance Test was then performed to determine if the variance within each group (each of the on-site locations and the combined reference data set) was equal (again, p value = 0.05.)
- If the data were non-normal, they were transformed to render the data more amenable to parametric statistics. Common statistical transformations used included logarithm base 10, natural logarithm, inverse, exponential, and square-root.
- If the data were normal and the groups possessed equal variance (at least, after transformation, as needed), a standard ANOVA was performed. If not, a non-parametric Kruskal-Wallis ANOVA on ranked data was performed. Statistical power was calculated for parametric ANOVAs.
- If a statistically significant difference was identified during the ANOVA test, multiple comparisons were performed to discern which groups were statistically different. For parametric ANOVAs, Dunnett's Method multiple comparisons was used to compare each group to the references. Multiple comparisons were not needed for non-parametric Kruskal-Wallis ANOVAs on ranked data.

4 Benthic Community Assessment Results

The benthic community assessment results are presented in this section using two different approaches. First, average conditions within each Reach are displayed. Second, average conditions at each sampling location are presented, and the locations sampled within SMAs are identified. This section is organized as follows:

- Section 4.1 provides the EPA and DNRE metric results for Reaches and individual locations, both in tabular and graphical formats. Observations about the metric results for Reaches and locations are also provided, particularly with regard to locations where samples were collected from within SMAs.
- Section 4.2 provides the EPA and DNRE multi-metric scoring results for Reaches and individual Locations, both in tabular and graphical formats, and including the summary statements of biological conditions within each Reach and individual location relative to the site-specific references and/or ecoregional reference. The following results are summarized:
 - EPA scoring and biological condition results by Reach
 - DNRE scoring and biological condition results by Reach/Location
 - EPA scoring and biological condition results by Location

4.1 Metric Results By Reach and Location

Metric results are tabulated for grab samples, HDs, and sweeps in Tables 4-1a, 4-1b, and 4-1c, respectively for Reaches and Locations. The metric results are illustrated for the Reaches in Figures 4-1a through 4-1l and for the Locations in Figures 4-2a through 4-2l:

Richness Metrics

- Taxa Richness: Figure 4-1a (Reaches) and Figure 4-2a (Locations)
- Total Number of Mayfly Taxa: Figure 4-1b (Reaches) and Figure 4-2b (Locations)
- Total Number of Stonefly Taxa: Figure 4-1c (Reaches) and Figure 4-2c (Locations)
- Total Number of Caddisfly Taxa: Figure 4-1d (Reaches) and Figure 4-2d (Locations)

Community Composition Metrics

- Percent Mayfly Composition: Figure 4-1e (Reaches) and Figure 4-2e (Locations)
- Percent Caddisfly Composition: Figure 4-1f (Reaches) and Figure 4-2f (Locations)
- Percent Isopods, Snails, and Leeches: Figure 4-1g (Reaches) and Figure 4-2g (Locations)

Tolerance Metrics

- Percent Dominant Taxon: Figure 4-1h (Reaches) and Figure 4-2h (Locations)
- Percent Surface Dependent: Figure 4-1i (Reaches) and Figure 4-2i (Locations)
- Hilsenhoff Biotic Index: Figure 4-1j (Reaches) and Figure 4-2j (Locations)

Functional Feeding Group Metric

- Percent Filterers: Figure 4-1k (Reaches) and Figure 4-2k (Locations)

Relevant Metric Associated With Other Metrics

- Abundance: Figure 4-1l (Reaches) and Figure 4-2l (Locations)

4.1.1 Observations Regarding EPA Metric Results by Reach

Metrics are illustrated for grabs, HDs, and sweeps on Figure 4-1a through 4-1l for the Reaches. The graphics show the reference areas and the areas in Segments 1 and 2 and also show the Composite Reference value ultimately used for the EPA and DNRE scoring described in Section 4.2. As mentioned previously, Reaches A and B are located upstream/upgradient from Dow's MiOps facility, and therefore all graphics show Reaches A and B color-coded as reference areas.

- The taxa richness graphic shows a few patterns that are prevalent among many of the metric figures, regardless of whether divided into Reach or location groupings (Figure 4-1a). Observations include the following:
 - Grab sample results for the Tittabawassee River reference (TR-Ref) show higher quality conditions than the Chippewa River reference (CR-Ref), but these differences were not observed using the HD or sweep sampling methods. These differences are attributable to substrate/habitat dissimilarities (e.g., lower sediment TOC content in the Chippewa River), as discussed in Section 2.
 - In the grab samples, Reach B results are very similar to the TR-Ref while the Reach A results are very similar to the CR-Ref location. This outcome is consistent with water flow and tributary mixing influences at these two locations, as they exist in areas of the confluence distinctly influenced by one river or another, as illustrated in Figure 2-3c.
 - Overall, the taxa richness scores show a diverse community within the river in all Reaches that is generally comparable with reference areas. Reach E, in particular, shows a diverse community using all sampling methods.
- The mayfly taxa metric results are presented on Figure 4-1b. Noted observations are below:

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- Mayflies were seen at all locations and were often abundant.
 - Mayfly taxa results are generally comparable among locations, except for grab samples in Reach I and HD samples in Reach F. These results show lower mayfly taxa. These findings may be influenced by habitat quality.
 - The stonefly taxa metric results are presented on Figure 4-1c, and the number of stonefly differ based on sampling type:
 - One stonefly species (*Taeniopteryx sp.*) was observed in grab and sweep samples, and four species were observed in HD samples (*Taeniopteryx sp.*, *Allocaenia sp.*, *Haploperla brevis*, *Acroneuria sp.*).
 - Suitable habitat is needed to support this species. The greater abundance of species on HD samplers shows that flat crevice surfaces are preferred.
 - Caddisfly taxa were seen at all locations and were abundant (Figure 4-1d). The following additional observations were noted:
 - In grab samples, caddisfly taxa were highest at the TR-Ref and Reach E and lowest in Reach B (RB-013+50). Similar low caddisfly richness results were also seen at Reaches A and B for HD samples and sweeps. The dip in taxa at Reach A and B is attributable, at least in part, to habitat differences.
 - The percent mayfly taxa metric results are provided on Figure 4-1e, and results show that:
 - Mayflies were abundant at all locations in all sampling types.
 - The highest abundance was seen in the TR-Ref location and this is at least in part due to the higher quality habitat conditions in this area.
 - The percent caddisfly taxa metric results are provided on Figure 4-1f, and results indicate:
 - Caddisflies were abundant at all locations in all sampling types, with some exception noted in Reaches A and B in all sampling types.
 - The highest abundance was seen in the TR-Ref location which is attributable at least in part due to the higher quality habitat conditions in this area.
 - The percent isopods, snails, and leeches results are provided on Figure 4-1g. These results show the following:
 - The majority of results fall in the optimal range for all locations (i.e., <6%).
 - The suboptimal range for this metric is >15%. No locations exceeded this value for any sample type, though the Reach B sweep was just below that threshold.
 - The percent dominant taxon indicates if a few species dominate the community. However, it is also important to recognize what the dominant species are. Metric results are presented in Figure 4-1h, and tabular summaries of dominant taxa for each sample type are provided in Tables 4-2a, 4-2b, and 4-2c for grabs, HDs, and sweeps, respectively. The following observations were noted:
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- In accordance with DNRE and EPA scoring, conditions are optimal when this value does not exceed 16% and 20%, respectively. A degraded community shift may be considered present if the percent dominant taxon is greater than 40%.
 - Sweep samples show the most balanced communities, HD samplers show the least balanced communities.
 - Reaches H and I have averages of ~50% dominance, with dominant species of the Tubificida naiad worm (*Nais sp.*).
 - TR-Ref locations have high percent dominance, but note that they are often dominated by sensitive species (mayflies, stoneflies, and caddisflies).
 - The percent surface dependent taxa metric results are provided on Figure 4-1i, and observations include the following:
 - With only limited exceptions described below, all results for all sample types were in the optimal range (less than 10%).
 - Only two replicates had results outside the optimal range, but even those do not exceed a suboptimal range (greater than 23%).
 - The percent surface dependent species are most abundant in grab samples at locations CR-Ref and Reach B. The Reach B location (RB-013+50) is on the side of the river most influenced by the Chippewa River (Figure 2-3c). Two of the three replicates at this location and all three replicates at the CR-Ref location were within normal ranges for this metric.
 - The HBI metric results are provided on Figure 4-1j, and the results indicate:
 - The HBI scores were generally comparable among locations and sample types, with a potential exception being the HD samples.
 - In the HD samples, the TR-Ref had the lowest values, and therefore, the highest quality condition. All other locations in the CR-Ref and Segment 1 had higher HBI values than the TR-Ref location. Reaches H and I had the highest HD HBI values but were within the range seen in the CR-Ref and Reaches A and B.
 - The HBI scale is from 0 to 10, with 10 reflecting degraded conditions, such as those related to municipal sewage treatment. Values in the intermediate range seen at all locations do not suggest degraded conditions and does not point to any particular degradation patterns.
 - The percent filterers metric results (Figure 4-1k) show the following:
 - The percent filterers are comparable among locations except that Reaches A and B show the lowest values in both grab and sweep samples. These results are consistent with the higher percent of surface dependent species at these locations. Habitat constraints and/or the presence of stormwater outfalls in the vicinity of these locations could influence these benthic community results.
 - The abundance metric is a simple count of the number of organisms at each location. This metric alone does not indicate whether conditions are good or degraded unless high numbers of pollution tolerant species are seen. Figure 4-1l illustrates that:
-

- Reaches H and I have some of the highest abundance with Hester Dendy samples, and these samples were dominated by the tolerant midge (*Rheotanytarsus sp.*) and the worm (*Nais sp.*).
- CR-Ref sweep results also show high abundance and Table 4-2c shows that these are dominated by amphipods and caddisflies, which are generally considered pollution sensitive. Reach E grabs show the highest abundance of this sample type and they were dominated by caddisflies, midge, and naiad worms, which are both pollution sensitive and pollution tolerant (Table 4-2a).

4.1.2 Observations Regarding EPA Metric Results by Location

Figures 4-2a through 4-2l provide the same metrics just discussed in detail above for Reaches, with the difference being that each location, including those within SMAs, is identified. These metric results are not discussed in detail here because a review of the graphics shows that most, if not all, of the observations made for the Reaches applies to the locations as well. The most notable observation with regard to the SMAs that can be made is that it does not appear that the results from locations within SMAs are substantively different than other areas.

4.2 Multi-Metric Scoring Results and Biological Condition Statements

This section presents the EPA and DNRE multi-metric scoring results for Reaches and individual Locations, both in tabular and graphical formats, including the summary statement of biological condition (i.e., impairment status) for each Reach and individual location relative to the site-specific references and the ecoregional reference. The following information is presented:

- EPA scoring and biological condition results by Reach
 - Figures 4-3a and 4-3b for grabs (based on Tables 4-3a and 4-3b)
 - Figures 4-4a and 4-4b for HDs (based on Tables 4-4a and 4-4b)
 - Figures 4-5a and 4-5b for sweeps (based on Tables 4-5a and 4-5b)
 - This analysis also includes the results of the statistical analysis for Reaches compared to the Composite reference. The full details of the statistical evaluation for Reaches are provided in Appendix F. Each of the series of figures (4-3 and 4-4) provide the results of a statistical evaluation by the identification of statistical groupings.
- DNRE scoring and biological condition results by Reach
 - Figures 4-6a and 4-6b for sweeps (based on Tables 4-6a and 4-6b)
- EPA scoring and biological condition results by locations, including locations sampled within SMAs
 - Figures 4-7a and 4-7b for grabs (also based on location scoring provided with Reach scoring in Tables 4-3a and 4-3b)

- Figures 4-8a and 4-8b for HDs (also based on location scoring provided with Reach scoring in Tables 4-4a and 4-4b)
- Figures 4-9a and 4-9b for sweeps (based on Tables 4-5a and 4-5b)
- This analysis also includes consideration of habitat scores relative to the biological condition scoring (Figures 4-7b, 4-8b, and 4-9b), and all of the Figure 4-7, 4-8, and 4-9 series provide the results of a statistical evaluation of the locations compared to the Composite Reference. The full details of the statistical evaluation for the locations are provided in Appendix G.

The remainder of this section provides observations regarding the EPA and DNRE multi-metric scoring and statements of biological condition. The metrics most related to the overall understanding of biological condition are discussed and the statistical evaluation results are identified.

4.2.1 Observations Regarding EPA Biological Condition Results for Reaches

Biological condition results using the EPA approach for Reaches are provided in a series of tables and figures, as follows:

- The collective information for grab sampling shows that the biological condition ranges from non-impaired (Composite Reference, TR-Ref, Reach B, Reach E, Reach K, and Reach M) to slightly impaired (CR-Ref, Reach H, and Reach I) (Table 4-3b). Other Reaches show results that are scored as “non- to slightly impaired” (Reaches F and G). The metrics that contribute to the differences in scoring are primarily related to mayfly, stonefly, and caddisfly, as well as the percent filterers (Figure 4-3a). As indicated in Figures 4-3a and 4-3b, however, there are no statistically significant differences for Reaches E through M compared to the Composite Reference.
- The collective HD sampling results show that the biological condition ranges from non-impaired (Composite Reference, TR-Ref, CR-Ref, Reach E, Reach G, and Reach M) to slightly impaired (Reach A/B, Reach F, and Reach I) (Table 4-4b). Other Reaches show results that are scored as non- to slightly impaired (Reaches H and K). The same metrics that influenced the scoring of the grabs also influenced the scoring of the HDs, with the exception that the stoneflies were more abundant on HDs because they provide a better habitat. Similar to the grab results, as indicated in Figures 4-4a and 4-4b, no statistically significant differences were observed for Reaches E through M compared to the Composite Reference.
- The collective information for sweeps shows that the biological condition is non-impaired at all Reaches, with an exception of slight impairment at Reach A/B and non- to slightly impairment at Reach I (Figures 4-5a and 4-5b, Table 4-5b). Mayfly, stonefly and filterer metrics were scored much lower at Reaches A/B than any other Reach.

4.2.2 Observations Regarding DNRE Biological Condition Results for Reaches

Biological condition results using the DNRE approach for Reaches are provided on Figures 4-6a and 4-6b for sweeps.

- This collective information shows that the biological condition ranges from “excellent” (TR-Ref, CR-Ref, Reaches F, H, K, and M) to tending toward excellent (Reaches A/B, E, G, and I).

4.2.3 Observations Regarding EPA Biological Condition Results for Locations

Biological condition results using the EPA approach for locations are similar to those for the Reaches, and therefore, only those notable locations that influence the Reach results are mentioned specifically. Location-specific scoring is provided in Tables 4-3a, 4-4a, and 4-5a for grabs, HDs, and sweeps, respectively. Scoring results are summarized in Tables 4-3b, 4-4b, and 4-5b accordingly. The results are graphically illustrated in Figures 4-7a and 4-7b for grabs, in Figures 4-8a and 4-8b for HDs, and in Figures 4-9a and 4-9b for sweeps. The results of the statistical analyses are also provided in the figures for grabs and HDs. The following observations were noted:

- For grab samples (Table 4-3b, Figure 4-7a and 4-7b), the most impaired location was in Reach B (location RB-013+50). Figure 4-7b shows that this location had one of the lower habitat scores, but habitat conditions alone may not be the only cause of the differences because other locations scored similarly. There are stormwater outfalls just upstream from Reach B. It is possible that contributions from the outfalls may also contribute to the community condition. Both locations in Reach I are designated as slightly impaired. The location RE-062+00 within the SMA was scored as non-impaired. There were no statistically significant differences observed between locations within Reaches E through M compared to the Composite Reference. The collection of samples within SMAs (albeit only two) did not appear to influence the results.
- For HD samples (Table 4-4b, Figure 4-8a and 4-8b), the most impaired location was in Reach I (location RI-164+50). Figure 4-8b shows that this location had one of the lower habitat scores (and lower multi-metric scores for the grab samples). Three HDs were placed within Reach I and the scoring ranged from non-impaired to moderately impaired. Location RI-164+50 did show a statistically significant difference compared to the Composite Reference. This location was dominated by a pollution tolerant worm and had several metrics showing low results. In addition, location RH-150+00 also showed a statistically significant difference when compared to the Composite Reference. This location is in SMA6 where ethyl parathion has previously been detected at elevated concentrations. No other locations showed statistically significant differences compared to the Composite Reference. Overall, the collection of HD samples within SMAs did not appear to influence the results.
- The sweep samples (Table 4-5b, Figure 4-9a and 4-9b) showed very similar results as those already mentioned for the Reaches. One sweep location was located within an SMA (Location RE-062+00), and this location scored non-impaired (Table 4-5b).

5 Summary and Conclusions

The primary objective of the 2010 benthic community study was to provide an approach for evaluating the condition of the benthic community in the Tittabawassee River using standard EPA and DNRE sampling methods, assessment protocols, and analysis procedures. The objective was accomplished by:

- Sampling 21 locations from 9 Reaches including reference stations located in the upstream Tittabawassee River, upstream Chippewa River, and below the Tittabawassee/Chippewa confluence and upstream from Dow's MiOps facility.
- Collecting and analyzing data from 167 discrete benthic community samples using three sampling methods (grabs, HDs, and sweeps).
- Systematically evaluating river habitat characteristics, water quality measurements, and sediment substrate characteristics.
- Providing a detailed account of the sampling and data analysis methods used to conduct the study including the use of EPA and DNRE multi-metric assessment approaches.

The sampling design and standard methods utilized in this study provided an opportunity to objectively compare and evaluate potential spatial trends in benthic community structure and condition for locations upstream and downstream from Dow's MiOps facility in Midland, Michigan. Data were compared using a site-specific reference approach consistent with EPA methods and the eco-regional reference approach consistent with DNRE methods. The standardized, multi-metric approaches utilized in this study allowed for analysis of potential relationships between community structure metrics, habitat factors, and chemical stressors through the location-specific analysis of data, including consideration of results for samples collected within and near SMAs. The results of these analyses are summarized below:

- Results of this study demonstrated the value of the multi-metric and multi-reference approach, and generally indicated that benthic communities adjacent to and downstream from Dow's MiOps facility (down to Reach M) were robust (diverse, abundant) and not significantly different from reference conditions. The benthic community assessment multi-metric scoring results that support the conclusions of robust communities on a Reach-wide basis are summarized in Table 5-1 for each of the multi-metric scoring approaches (EPA and DNRE) and sampling methods (grabs, HDs, and sweeps), and are summarized as follows:
 - Conditions in Reaches E through M, when compared to the DNRE ecoregional reference approach, scored from excellent to tending toward excellent.
 - Conditions in Reaches E through M, when compared to reference areas using the EPA approach, scored from non-impaired to slightly impaired, depending on the Reach and sampling type.
 - Statistical testing on a Reach basis did not identify any significant differences in benthic community structure between reference conditions and Reaches E through M.

Aside from the Reach-based approach, statistical analysis of the dataset conducted on a per-sampling station (location) basis indicated that significant differences in benthic community structure metrics were observed for two locations where the potential localized effects of chemical contaminants and/or stormwater sources is possible.

- One location was in Reach H (RH-150+00), which is a station that was located within an SMA (SMA 6).
- The second location was in Reach I (RI-164+50), which had one of the lowest habitat characterization scores. This station was also represented by proportionally more pollution-tolerant species (i.e., tubificid worms). This location exhibited slightly higher scores for the HBI, suggesting potential organic (i.e., nutrient) enrichment.

Results from this study further suggested that some limitations to benthic community structure (both within Segment 1 and at reference sites) appear to be due to watershed-related, non-contaminant habitat factors (e.g., preponderance of sandy sediments, limited coarse substrates and woody debris, relatively low organic carbon sediments). This conclusion does not apply to all locations, as small and isolated areas of relatively high-quality benthic habitat were observed in virtually all reaches studied. Nevertheless, the conclusion that habitat limitation is a key factor affecting the organization of benthic communities in the Tittabawassee River is supported by the habitat characterization data and extensive observations made during this study.

The 2010 benthic community assessment results also show that community structure/condition in the Reaches evaluated in this study is consistent with that observed in other similar-sized rivers in this region of Michigan. This evaluation is provided in Figures 5-1 and 5-2 and is summarized below:

- Figure 5-1 shows the macroinvertebrate community ratings for Michigan wadeable and non-wadeable rivers for data collected between 2002 and 2007. There are some results for the Tittabawassee River, but not for Segments 1 and 2 or the reference locations included in the 2010 benthic community assessment. There are two locations near the Reach A location and upstream from the Chippewa Reference location. As shown on Figure 5-1, the results were reported as good to excellent.
- Figure 5-2 overlays the 2010 benthic study results with DNRE macroinvertebrate scoring for other rivers in Michigan. The results are presented along a continuum of macroinvertebrate scoring and habitat scoring. Blue circles show the 2010 results, gray circles show the DNRE dataset. The 2010 results fall within the marginal to excellent habitat ranges and the neutral to excellent macroinvertebrate ranges.
- EPA scoring was normalized to the DNRE scoring so that these data could also be compared to other similar-sized rivers in Michigan. Results for grabs, HDs, and sweeps were also within ranges of marginal to excellent habitat and neutral to excellent benthic community scores. For each sample type, lower macroinvertebrate scores were generally related to lower habitat scores.

A final objective of the 2010 study was to use information gained during the study to inform future benthic community assessment studies, if such studies are deemed necessary. Several key observations should inform future sampling efforts, should such sampling be undertaken:

- September is an appropriate timeframe for sampling the benthic community. Water levels are relatively low compared to spring, and therefore, more wadeable habitat is available for sampling. Wadeable habitat allows for sampling methods that more fully characterize the community than non-wadeable methods.
- Wadeable habitat characterization on a 200-point scale also allows comparability to the DNRE dataset. Non-wadeable habitat characterization on a 100-point scale allows comparability to a much smaller DNRE dataset.
- HD sampling and grab sampling results were comparable but showed some differences that make future use of both approaches valuable. Replicates are easier to obtain with HD samplers, and they show less variability than some of the grabs (which gives greater statistical strength in evaluations). In the future, however, only three replicate HD samplers may be warranted instead of the five used in the benthic community study. Further evaluation of the available data will provide greater insight into this issue.
- Coordination with and understanding of the water releases from the Sanford dam are critically important, both in terms of safety in the river as well as the ease and accuracy of sample collection. For example, water is not released on the weekend, and therefore, Monday morning water levels are at their lowest. Placement of HDs needs to account for the lowest water levels. Also, timing of sampling at lower flow conditions allows greater access to more suitable habitat conditions.

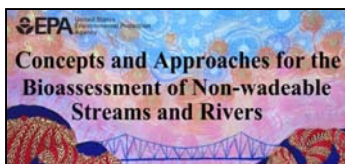
In summary, this benthic community study was successfully implemented, produced a technically strong and useful dataset, and numerous lessons were learned. The study sampling methodologies worked well. A wide range of habitat conditions were encountered and sampled. Suitable reference areas were identified, and the Composite Reference approach was shown to be a robust way to integrate results from numerous reference locations. While the results of this benthic community study are robust, it is recognized this assessment was only one sampling effort. The data collected during the benthic community study support the conclusion that the benthic community in Reaches E through M is diverse, abundant, and comparable to Composite Reference locations with two exceptions (as noted above for specific localized areas within Reaches H and I, which are either related to an unidentified SMA or ongoing stormwater discharges). Benthic community structure/condition at most locations was very comparable to (not different from) the Composite Reference conditions, even in most samples collected from within Segment 1 SMAs. Sampling results and observations from this benthic community study suggest that non-chemical habitat limitations (i.e., relative lack of structure and coarse particulate organic matter) influence the benthic community in Segments 1 and 2. In conclusion, results from this benthic community study indicate that the structure/condition of benthic communities within Segments 1 and 2 of the Tittabawassee River (down to Reach M) is comparatively similar to that observed at site-specific reference stations, as reflected by the Composite Reference, and consistent with eco-regional reference conditions.

6 References

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Figures



Habitat Assessment of Non-Wadeable Rivers in Michigan

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ABSTRACT: Habitat evaluation of wadeable rivers on accepted protocols provides a rapid adjunct to biological assessment. However, it has been devoted to habitat evaluation in streams where it is likely that protocols will differ. We developed a rapid protocol for wadeable habitat index (NWI) for non-wadeable rivers. We defined a wadeable river as a river with a drainage area ≥ 1600 km², mainstem mean annual discharge ≥ 15 m³/s. The

date rivers that ranged in length from 103 to 825 km and in drainage area from 1620 to 16,600 km². We measured 171 individual habitat variables over 24m reaches at 39 locations on 14 rivers during 2000–2002, where mean width was 10.5 m, depth 1.5 m, and velocity 0.1 m/s.

Rapid Bioassessment Protocols For Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish Second Edition

Periphyton, Benthic Macroinvertebrates, and Fish
Second Edition

This edition was revised to reflect the most current information available on the use of these protocols. The protocols were revised to reflect the most current information available on the use of these protocols. The protocols were revised to reflect the most current information available on the use of these protocols.

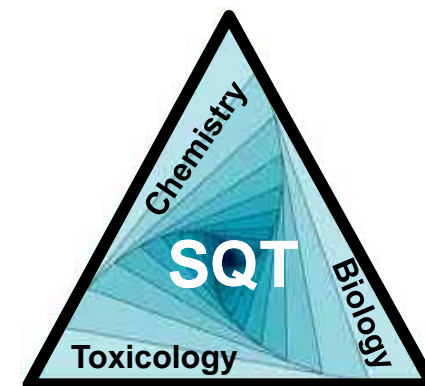


WATER BUREAU POLICY AND PROCEDURES

NUMBER: WB-SWAS-051
SUBJECT: QUALITATIVE BIOLOGICAL AND HABITAT SURVEY PROTOCOLS FOR WADEABLE STREAMS AND RIVERS
EFFECTIVE DATE: 1990, REVISED 1991, 1997, 2002
REVISION DATE: DECEMBER 2008
PAGE: 1 OF 53

The 2010 benthic community assessment documents conditions in the Tittabawassee River using Environmental Protection Agency (EPA) and Department of Natural Resources and Environment (DNRE) methods using a sediment quality triad (SQT)-type approach (EPA 1999, 2006, DEQ¹ 2008, Wilhelm et al. 2005, DEQ/Creel et al. 1998, EPA 2002). An SQT is an integration of multiple lines of evidence related to chemistry, toxicology, and biological community assessment (EPA 2002).

An overarching goal of the 2010 study was to characterize the biological community in the river as a whole. Therefore, multiple sampling techniques were used. In addition, samples were located in many sediment management areas (SMAs), but it was not the goal of the study to exclusively characterize only those SMAs. As such, benthic community assessment locations were not specifically co-located with toxicity testing locations.



¹ References to Michigan Department of Environmental Quality (DEQ) guidance is provided for accuracy in a manner consistent with DNRE posting of guidance documents on the DNRE website (e.g., "Procedure 51" guidance is posted on the DNRE website under the title "DEQ Water Bureau Policy and Procedures").



Benthic Community Assessment Methods and Sediment Quality Triad



Tittabawassee River Segments and Surrounding Areas

Benthic Community Assessment Report

Figure
2-1a



Three benthic community sampling types were used:

- Sediment grab samples were collected using a Surber sampler
- Hester-Dendy artificial substrate samplers were used, attached to rebar and secured as close to the sediment surface as possible to remain suspended without getting adversely affected from mud deposition
- Qualitative, multi-habitat sweep-net samples were collected using a D-frame net

The following number of samplers that were deployed, retrieved, and samples collected were:

- Grab samples
 - 19 locations from 9 Reaches + TR and CR reference
 - 3 replicates per location
 - 57 discrete samples
- Hester-Dendy artificial substrates (HDs)
 - 21 locations from 9 Reaches + TR and CR reference
 - 5 replicates per location
 - 105 discrete samples deployed
 - 96 HDs retrieved (See section 2.2 for description of HDs not recovered)
- Sweep samples
 - 14 locations from 9 Reaches + TR and CR reference
 - 14 discrete samples

TR – Tittabawassee River

CR – Chippewa River

HD – Hester-Dendy



Grabs: Surber Sampler



Hester-Dendy Samplers



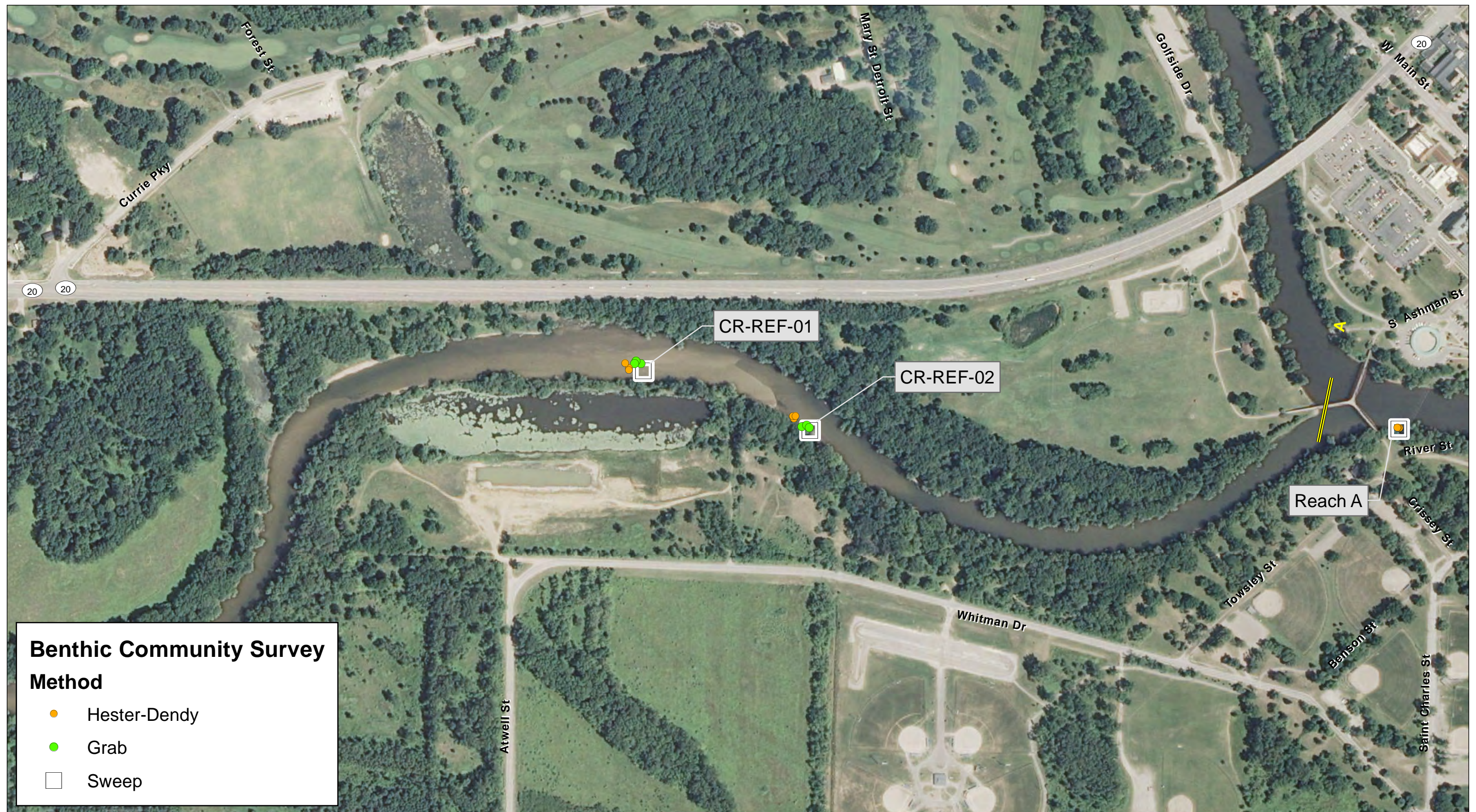
Dip Net: Multi-habitat Sweep



Benthic Community Sample Collection Equipment

Benthic Community Assessment Report

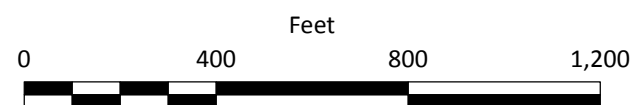
Figure
2-2





Reference Sampling Stations - Tittabawassee River
2010 Pilot Benthic Community Study
Tittabawassee/Saginaw Segment 1 Response Proposal

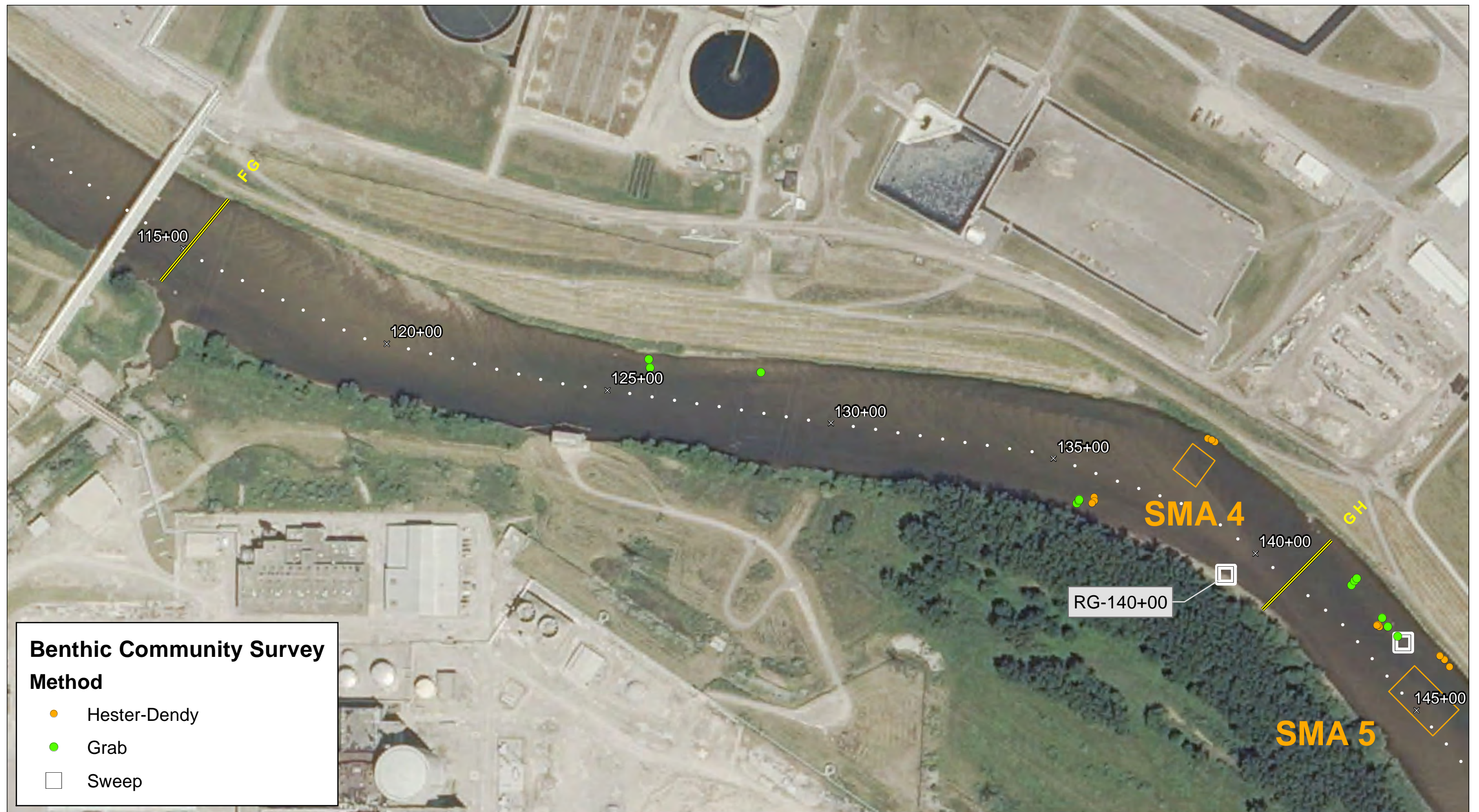
Figure
2-3b











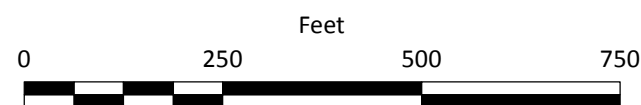




Benthic Community Survey

Method

- Hester-Dendy
- Grab
- Sweep



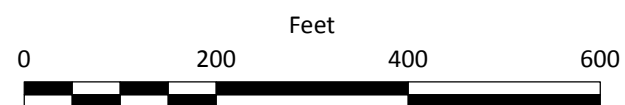
Benthic Sampling Stations - Reach K
2010 Pilot Benthic Community Study
Tittabawassee/Saginaw Segment 1 Response Proposal

Figure
2-3i

Benthic Community Survey

Method

- Hester-Dendy
- Grab
- Sweep



Benthic Sampling Stations - Reach M
2010 Pilot Benthic Community Study
Tittabawassee/Saginaw Segment 1 Response Proposal

Figure
2-3j



Ecoregion:

- Eastern Corn Belt Plains
- Huron/Erie Lake Plains
- North Central Hardwood Forests
- Northern Lakes and Forests
- Southern Michigan/Northern Indiana Drift Plains

Michigan Department of Natural Resources and Environment is based on a comparison of metrics to the appropriate ecoregion, as defined in Omernik 1987 (DNRE 2008, DEQ/Creel et al. 1998)

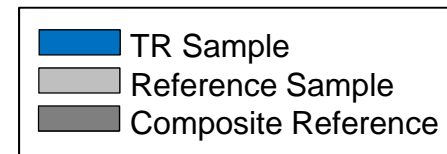
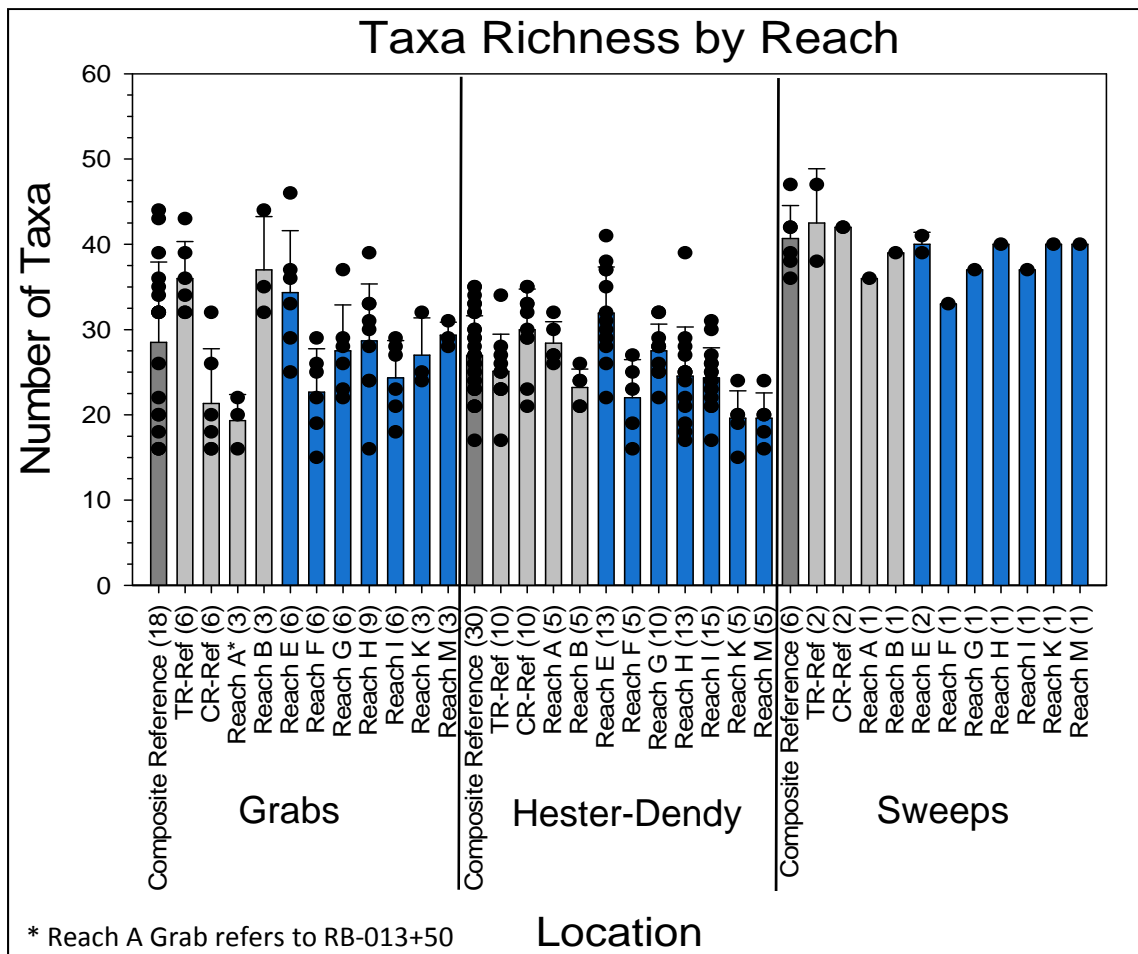
The Tittabawassee River Study Area included in the 2010 benthic community assessment are located in the Huron/Erie Lake Plains ecoregion.



Ecoregions of the Conterminous United States: Michigan

Benthic Community Assessment Report

Figure
3-1



Notes:

- Number of taxa reflects community diversity; higher values reflect higher quality conditions.

Graphing:

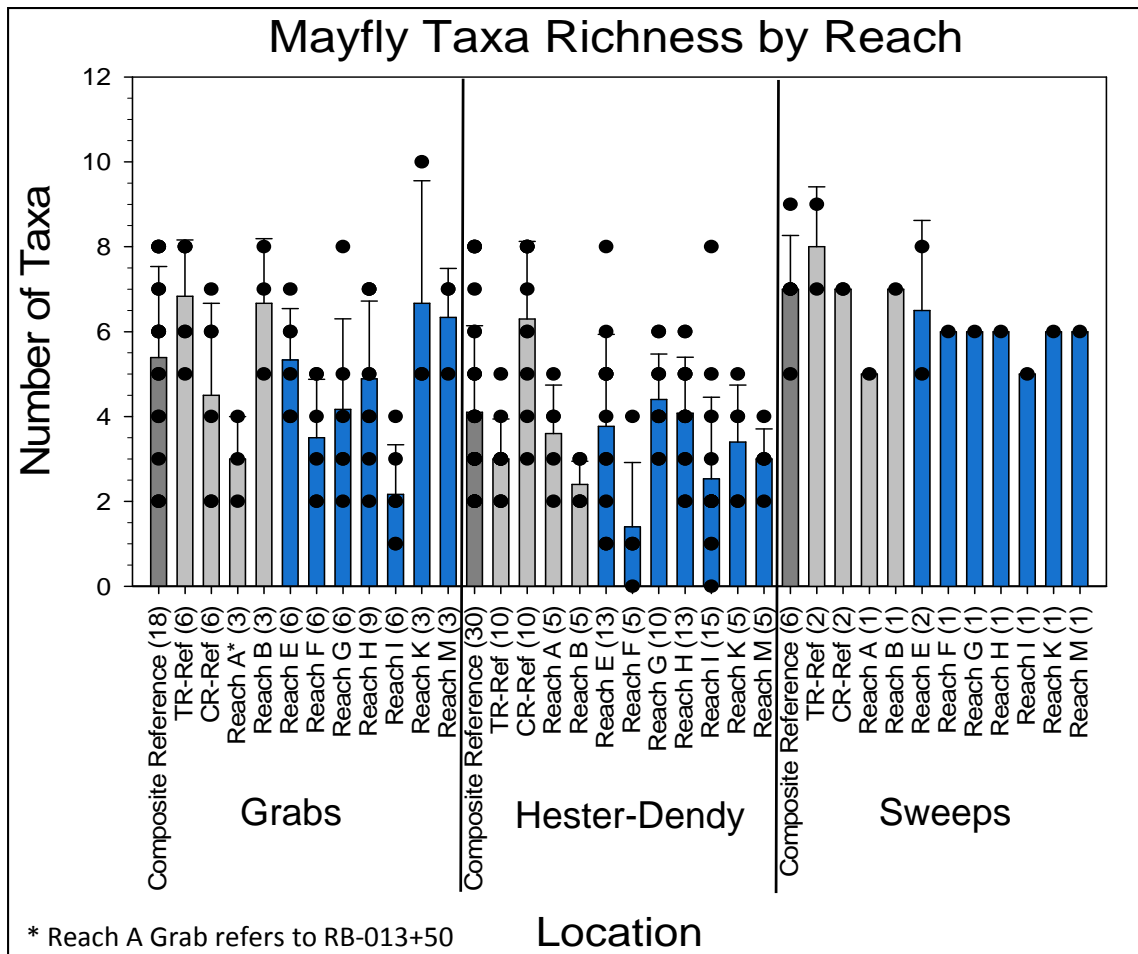
- Bars/whiskers reflect the mean and one standard deviation for the replicates in each sample.
- Circles reflect the individual replicate result. Note that some circles may overlap.
- Replicate counts are provided as numbers in parentheses along the x-axis labels.
- Replicates as follows: Hester-Dendy = 5; grabs = 3, sweeps = 1.

Reference Areas:

- TR = Tittabawassee River
- CR = Chippewa River
- Reaches A & B

- Grab sample results for the TR-Ref show higher quality conditions than the CR-Ref, but these differences were not observed using the HD or sweep sampling methods. This is due to habitat differences discussed in Section 2.
- In the grab samples, Reach B location results are very similar to the TR-Ref while the Reach A location results are equally as similar as the CR-Ref location. This outcome is consistent with water flow influences at these two locations, as they exist in areas of the confluence distinctly influenced by one river or another, as illustrated in Figure 2-3c.
- Overall, the taxa richness scores show a diverse community within the river in all Reaches that is generally comparable with reference areas. Reach E, in particular, shows a diverse community using all sampling methods.





Notes:

- Mayflies are pollution sensitive. Higher values indicate higher quality conditions.

Graphing:

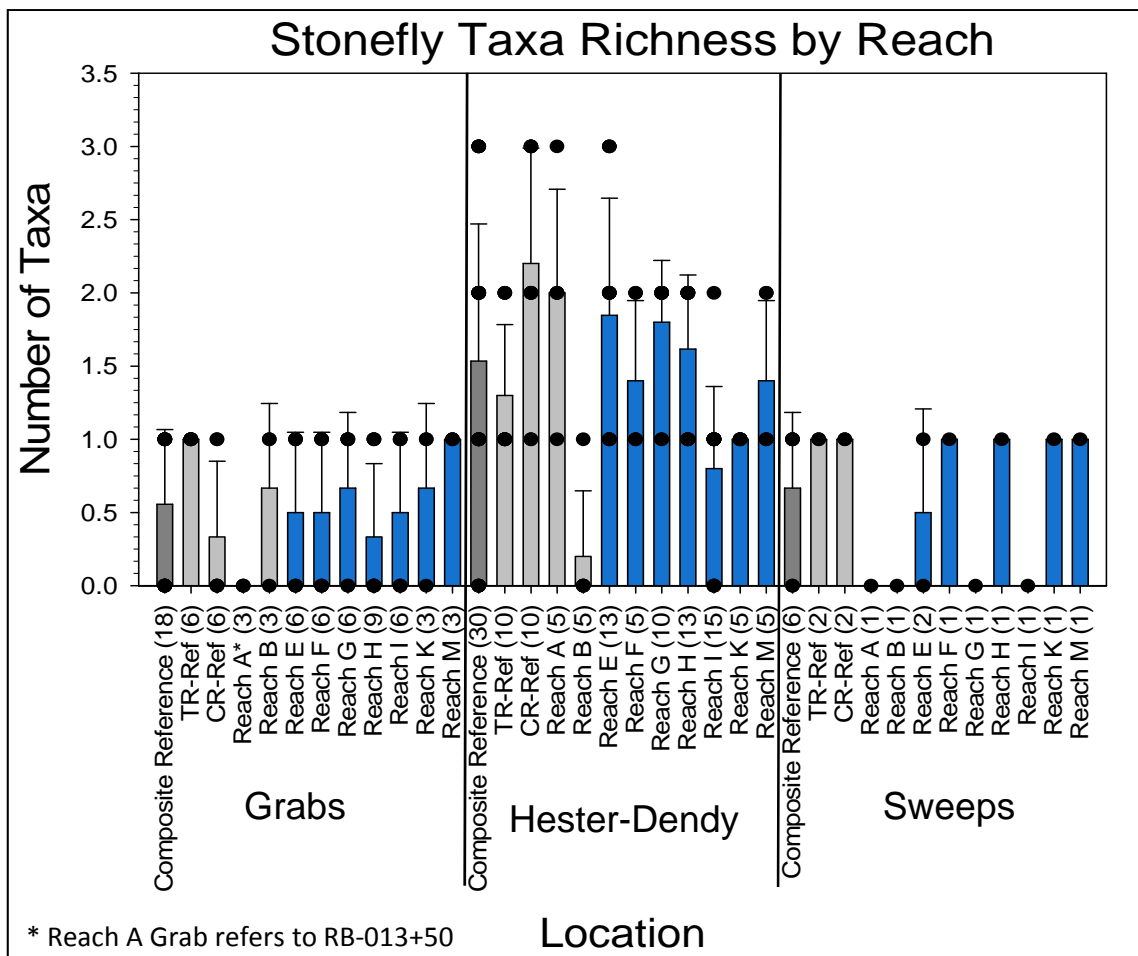
- Bars/whiskers reflect the mean and one standard deviation for the replicates in each sample.
- Circles reflect the individual replicate result. Note that some circles may overlap.
- Replicate counts are provided as numbers in parentheses along the x-axis labels.
- Replicates as follows: Hester-Dendy = 5; grabs = 3, sweeps = 1.
- HD = Hester-Dendy

Reference Areas:

- TR = Tittabawassee River
- CR = Chippewa River
- Reaches A & B

- Mayflies were seen at all locations and were often abundant.
- Mayfly taxa results are generally comparable among locations, except for grab samples in Reach I and HD samples in Reach F. These results show lower mayfly taxa. These findings may be influenced by habitat quality.





Notes:

- Stoneflies are pollution sensitive. Higher values indicate higher quality conditions.

Graphing:

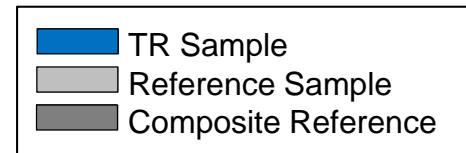
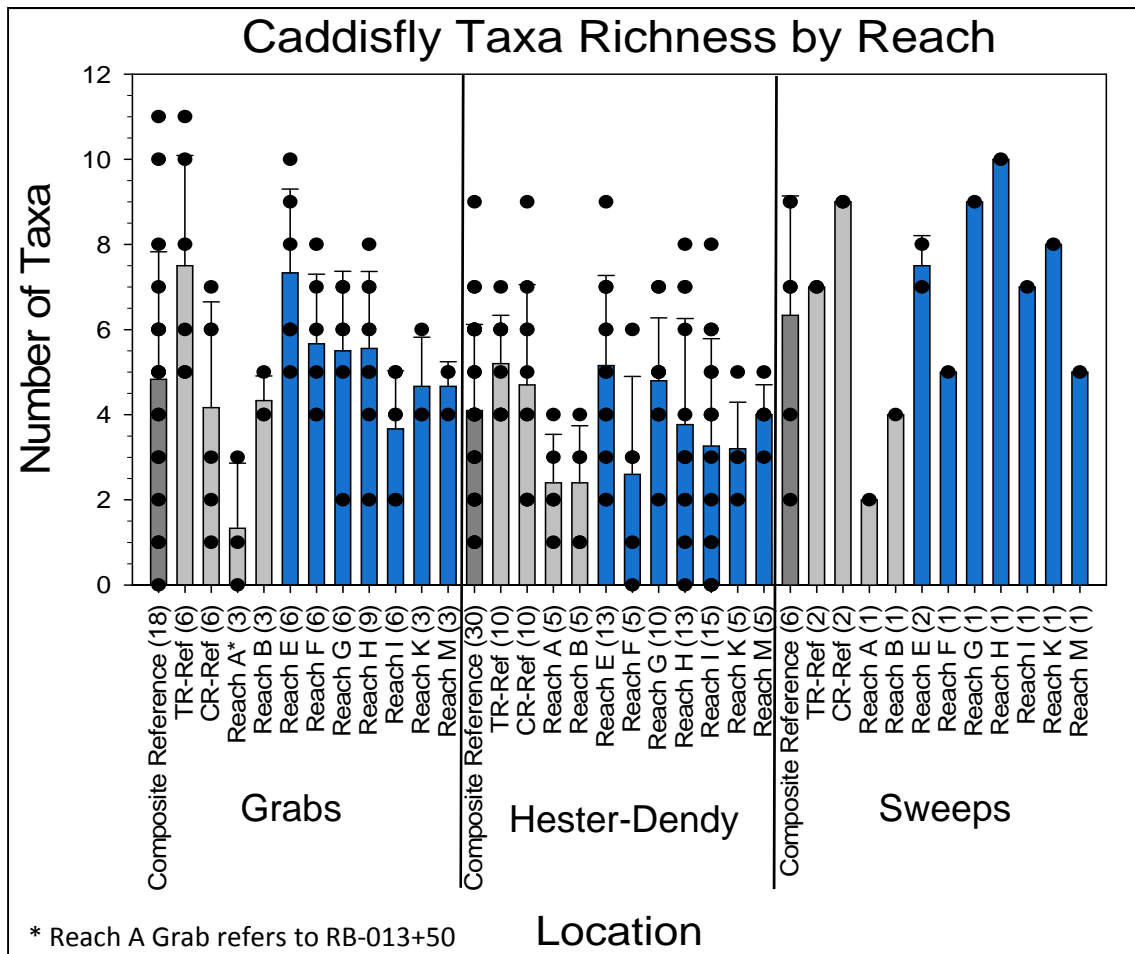
- Bars/whiskers reflect the mean and one standard deviation for the replicates in each sample.
- Circles reflect the individual replicate result. Note that some circles may overlap.
- Replicate counts are provided as numbers in parentheses along the x-axis labels.
- Replicates as follows: Hester-Dendy = 5; grabs = 3, sweeps = 1.

Reference Areas:

- TR = Tittabawassee River
- CR = Chippewa River
- Reaches A & B

- One stonefly species (*Taeniopteryx sp.*) was observed in grab and sweep samples and four species were observed in Hester-Dendy samples (*Taeniopteryx sp.*, *Allocapnia sp.*, *Haploperla brevis*, *Acroneuria sp.*).
- Suitable habitat is needed to support this species. The greater abundance of species on Hester-Dendy samplers shows that flat crevice surfaces are preferred.





Notes:

- Caddisflies are also considered pollution sensitive. Higher values represent higher quality conditions.

Graphing:

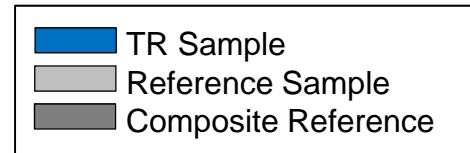
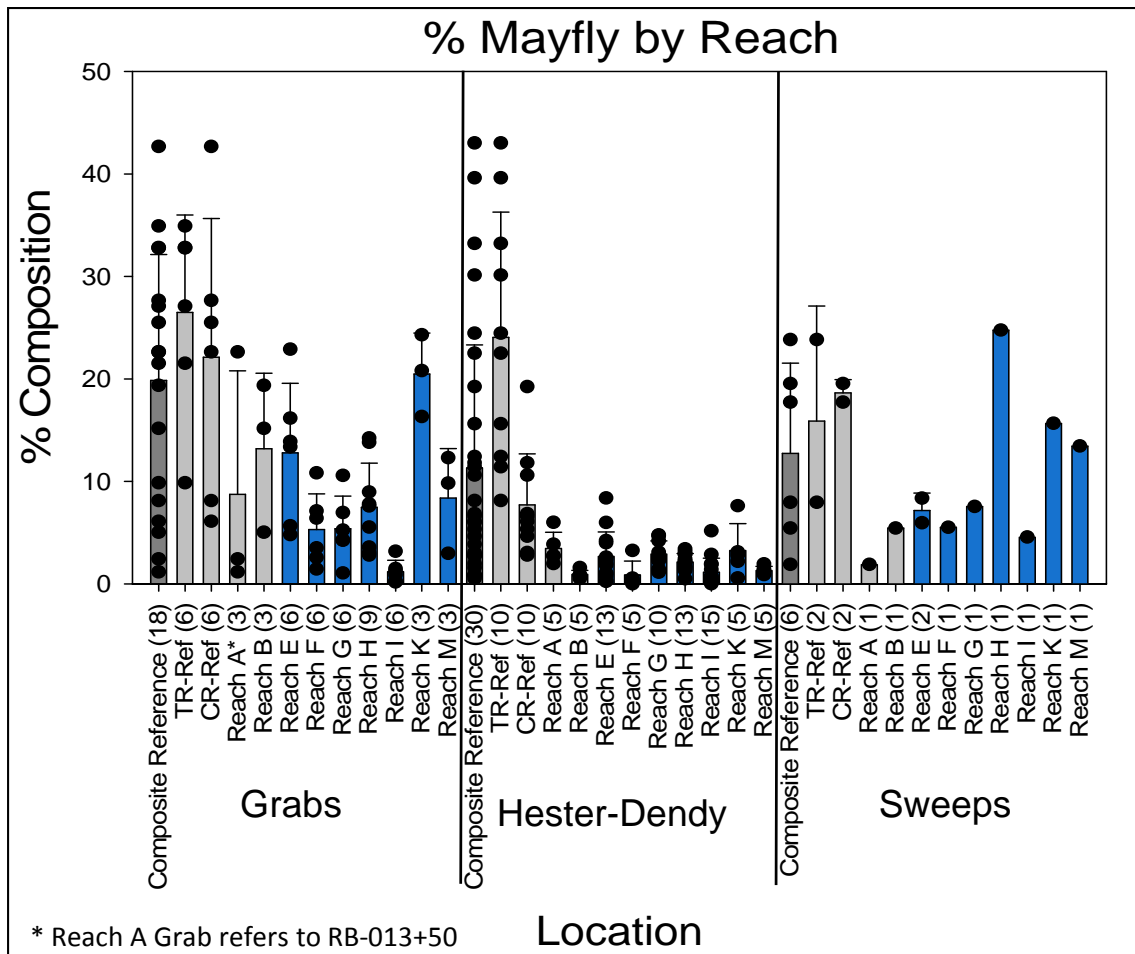
- Bars/whiskers reflect the mean and one standard deviation for the replicates in each sample.
- Circles reflect the individual replicate result. Note that some circles may overlap.
- Replicate counts are provided as numbers in parentheses along the x-axis labels.
- Replicates as follows: Hester-Dendy = 5; grabs = 3, sweeps = 1.

Reference Areas:

- TR = Tittabawassee River
- CR = Chippewa River
- Reaches A & B

- Caddisflies were seen at all locations and were often abundant.
- In grab samples, caddisfly taxa were highest at the TR-Ref and Reach E and lowest in the RB-013+50 location. Similar low caddisfly richness results were also seen at Reaches A and B for Hester-Dendy samples and sweeps. The dip in taxa at Reach A and B is considered due, in part, to habitat differences.





Notes:

- Mayflies are pollution sensitive. Higher values indicate higher quality conditions.

Graphing:

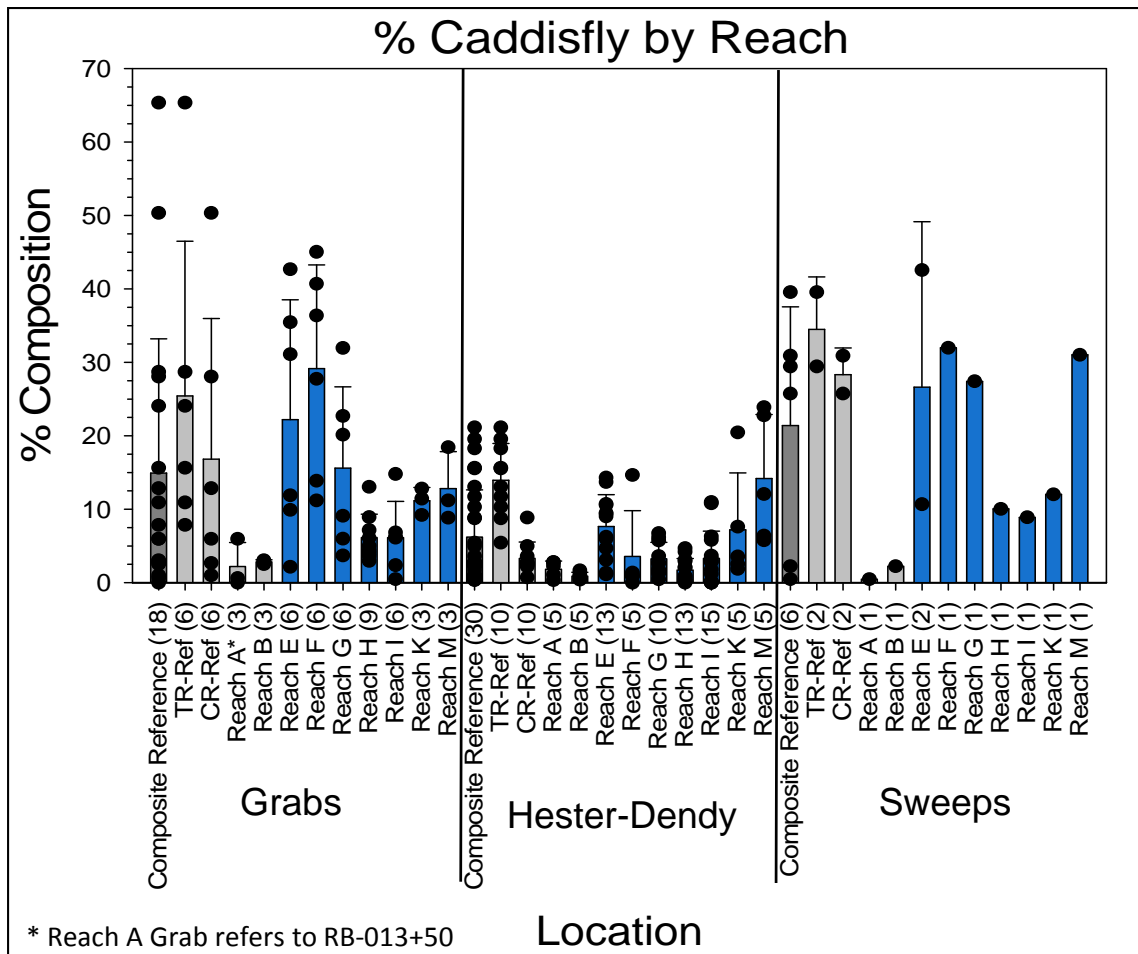
- Bars/whiskers reflect the mean and one standard deviation for the replicates in each sample.
- Circles reflect the individual replicate result. Note that some circles may overlap.
- Replicate counts are provided as numbers in parentheses along the x-axis labels.
- Replicates as follows: Hester-Dendy = 5; grabs = 3, sweeps = 1.

Reference Areas:

- TR = Tittabawassee River
- CR = Chippewa River
- Reaches A & B

- Mayflies were abundant at all locations in all sampling types.
- The highest abundance was seen in the TR reference location and this is at least in part due to the higher quality habitat conditions in this area.





Notes:

- Caddisflies are pollution sensitive. Higher values indicate higher quality conditions.

Graphing:

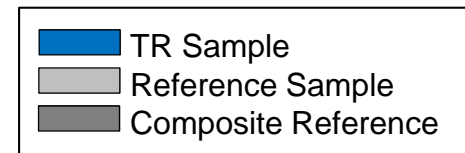
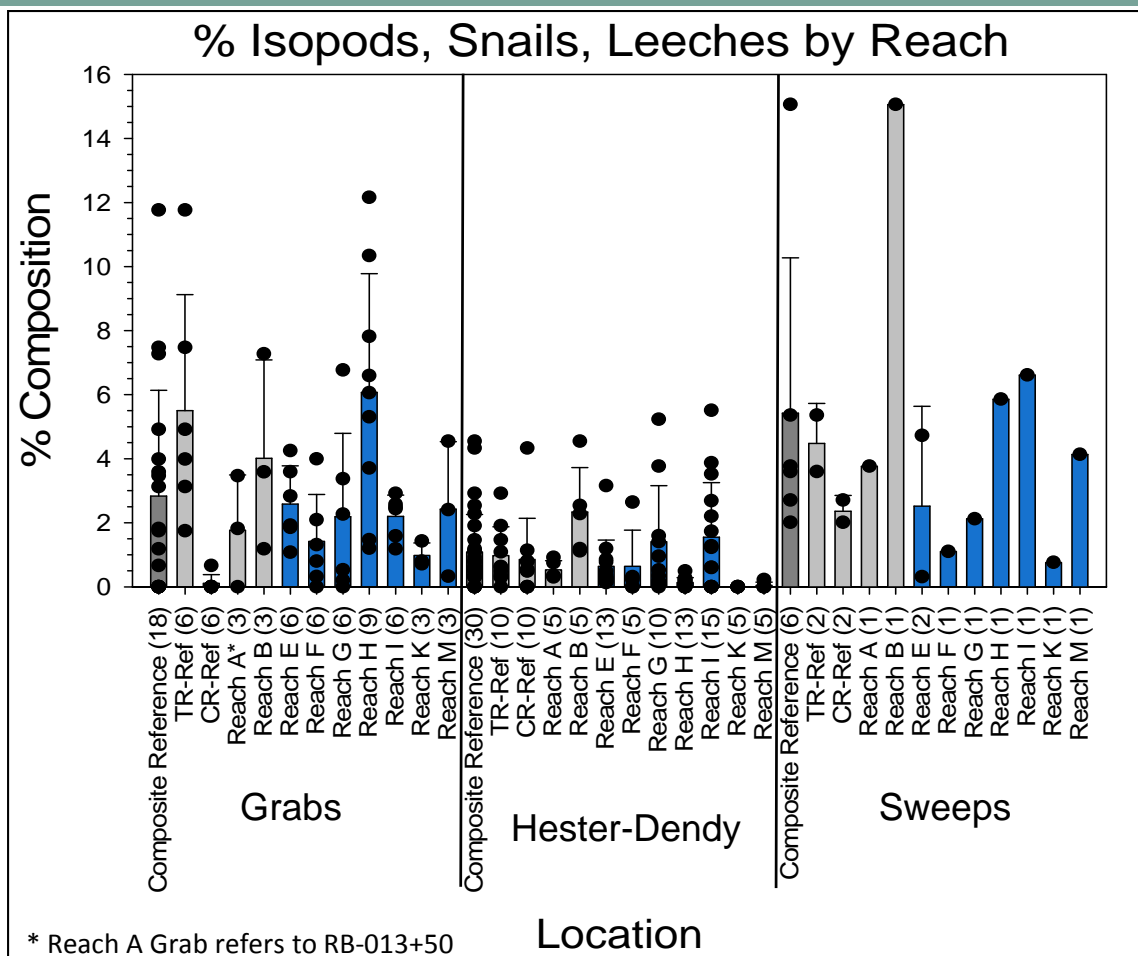
- Bars/whiskers reflect the mean and one standard deviation for the replicates in each sample.
- Circles reflect the individual replicate result. Note that some circles may overlap.
- Replicate counts are provided as numbers in parentheses along the x-axis labels.
- Replicates as follows: Hester-Dendy = 5; grabs = 3, sweeps = 1.

Reference Areas:

- TR = Tittabawassee River
- CR = Chippewa River
- Reaches A & B

- Caddisflies were abundant at all locations in all sampling types, with some exception noted in Reaches A and B in all sampling types.
- The highest abundance was seen in the TR reference location and this is at least in part due to the higher quality habitat conditions in this area.





Notes:

- These 3 taxa, when compared as a combined percentage of the invertebrate community, can give an indication of the severity of environmental perturbation present.
- Higher values indicate lower quality conditions (<6% is optimal).

Graphing:

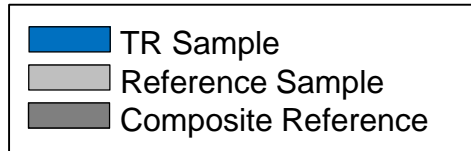
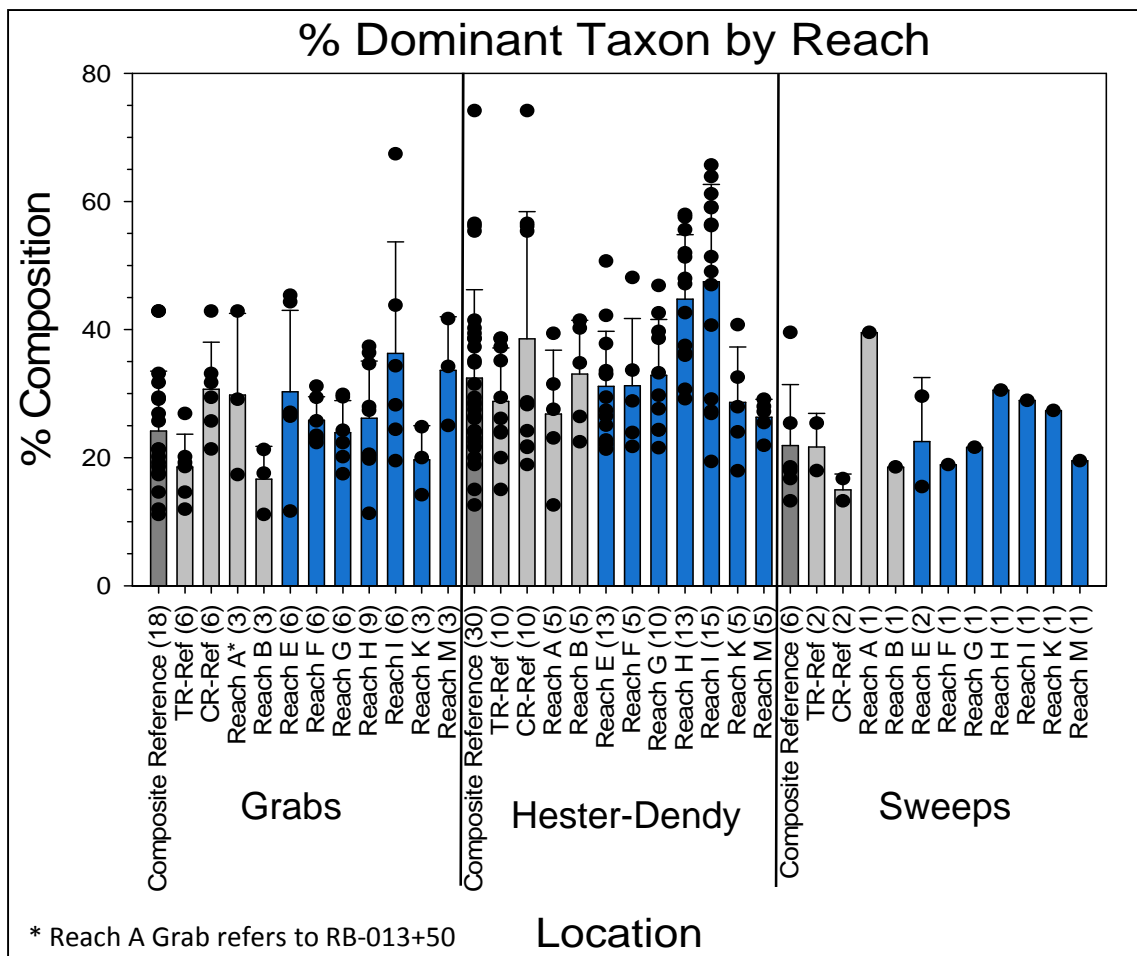
- Bars/whiskers reflect the mean and one standard deviation for the replicates in each sample.
- Replicates as follows: Hester-Dendy = 5; grabs = 3, sweeps = 1.
- Circles reflect the individual replicate result. Note that some circles may overlap.
- Replicate counts are provided as numbers in parentheses along the x-axis labels.

Reference Areas:

- TR = Tittabawassee River
- CR = Chippewa River
- Reaches A & B

- The majority of results fall in the optimal range for all locations (i.e., <6%).
- The suboptimal range for this metric is >15%. No locations exceed this value for any sample type, though it is noted that the Reach B sweep is just below that threshold.





Notes:

- The abundance of the numerically dominant taxon is an indication of community balance.
- Higher values indicate lower quality conditions.

Graphing:

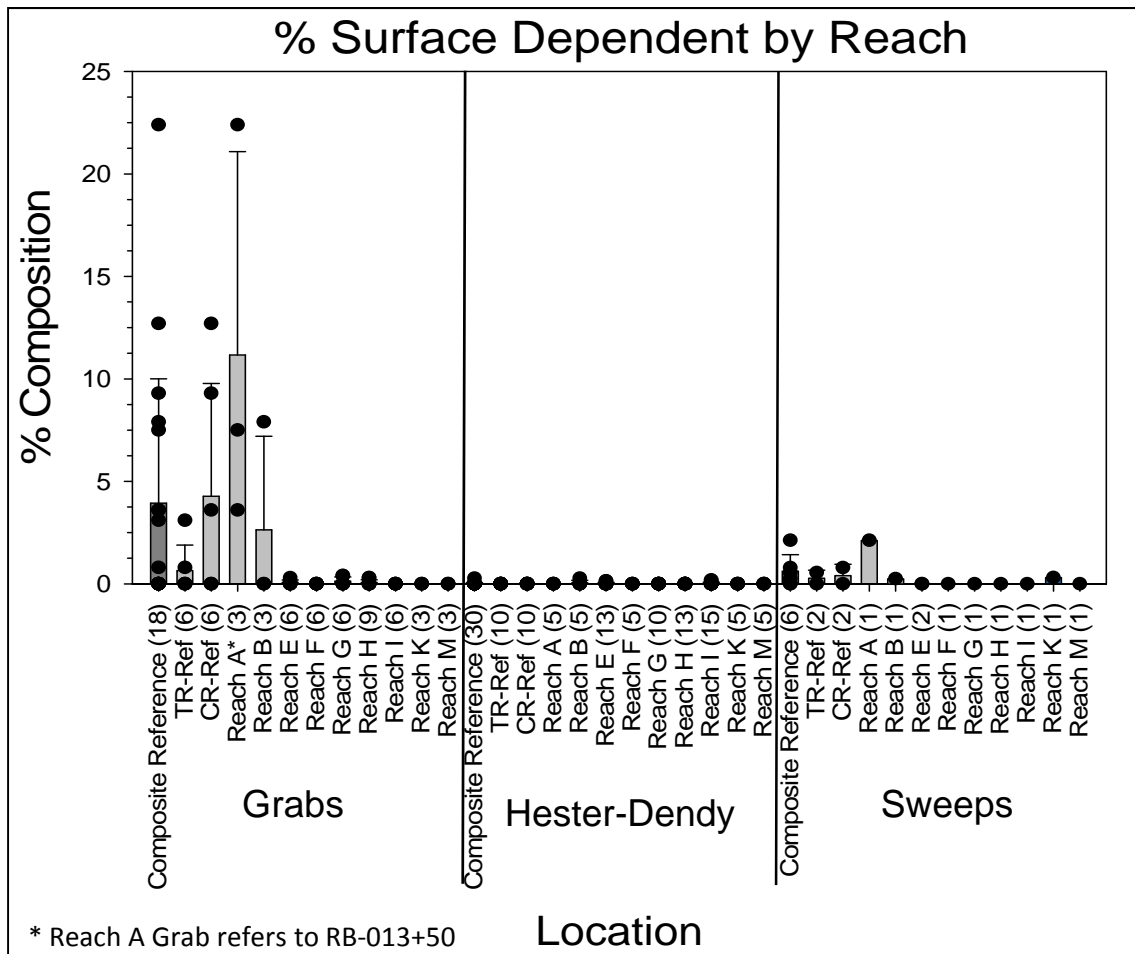
- Bars/whiskers reflect the mean and one standard deviation for the replicates in each sample.
- Replicates as follows: Hester-Dendy = 5; grabs = 3, sweeps = 1.
- Circles reflect the individual replicate result. Note that some circles may overlap.
- Replicate counts are provided as numbers in parentheses along the x-axis labels.
- HD = Hester-Dendy

Reference Areas:

- TR = Tittabawassee River
- CR = Chippewa River
- Reaches A & B

- In accordance with DNRE and EPA scoring, conditions are optimal when this value does not exceed 16% and 20%, respectively. A degraded community shift may be considered present if the %dominant taxon > 40%.
- Sweep samples show the most balanced communities, HD samplers show the least balanced communities.
- Reaches H and I have averages of ~50% dominance, with dominant species of the Tubificida niad worm (*Nais sp.*).
- TR-Ref locations have high % dominance, but note that they are often dominated by sensitive species (mayflies, stoneflies, and caddisflies).
- A listing of dominant species for each sampling type and reach is provided in Tables 4-2a, 4-2b, and 4-2c.





Notes:

- High percentages of surface dependent organisms may indicate dissolved oxygen shifts or other biological or chemical oxygen demanding constraints. Significantly higher values (e.g., > 25%) may indicate lower quality conditions or differences in habitat type.

Graphing:

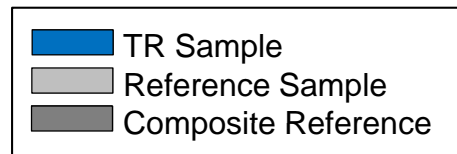
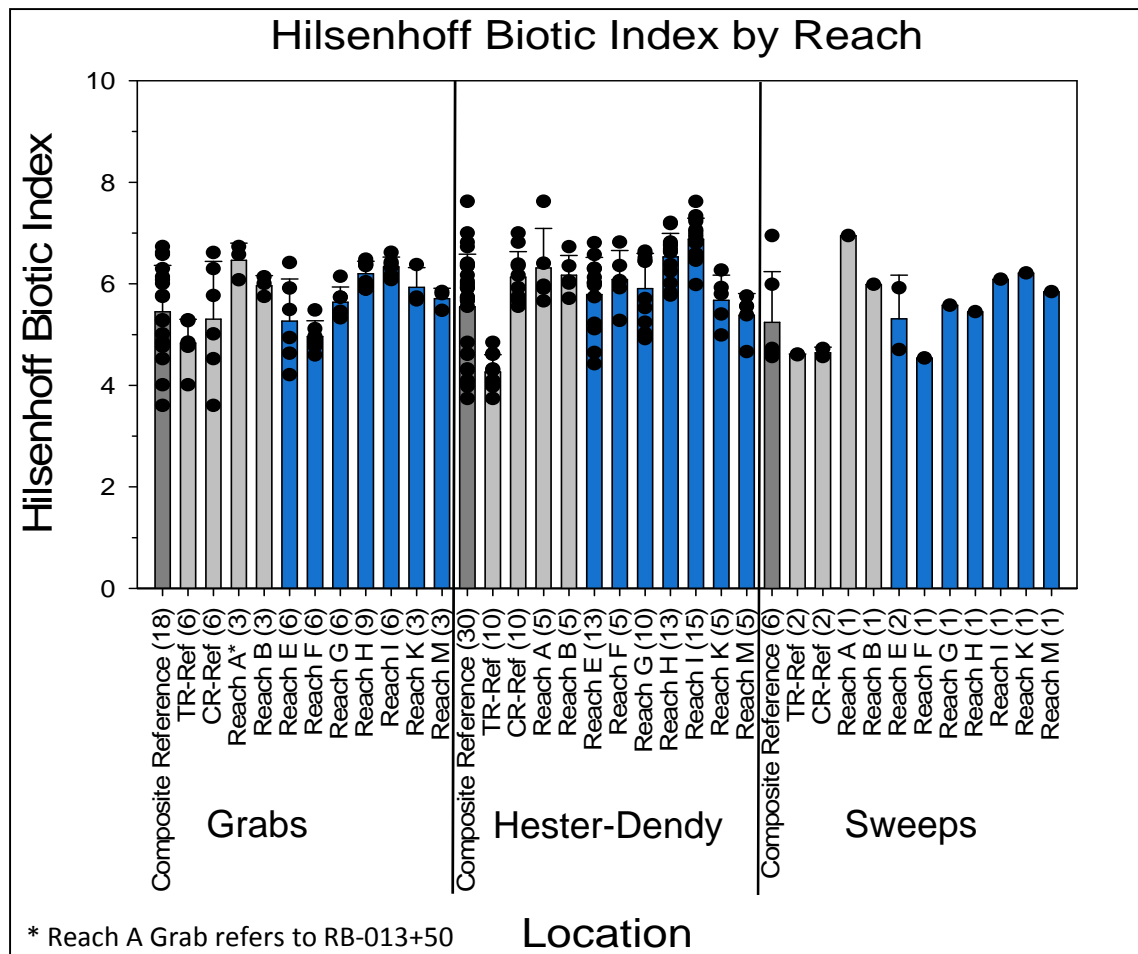
- Bars/whiskers reflect the mean and one standard deviation for the replicates in each sample.
- Circles reflect the individual replicate result. Note that some circles may overlap.
- Replicate counts are provided as numbers in parentheses along the x-axis labels.
- Replicates as follows: Hester-Dendy = 5; grabs = 3, sweeps = 1.

Reference Areas:

- TR = Tittabawassee River
- CR = Chippewa River
- Reaches A & B

- With only limited exceptions described below, all results for all sample types were seen in the optimal range (<10%).
- Only two replicates had results outside the optimal range, but even those do not exceed a suboptimal range (>23%).
- The percent surface dependent species are most abundant in grab samples at locations CR-Ref and Reach B. The Reach B location (RB-013+50) is on the side of the river most influenced by the Chippewa River (Figure 2-3c). Two of the three replicates at this location and all three replicates at the CR-Ref location were within normal ranges for this metric.





Notes:

- HBI – Hilsenhoff biotic index provides insight into municipal or treated wastewater shifts in community structure. Higher values generally reflect lower quality conditions.

Graphing:

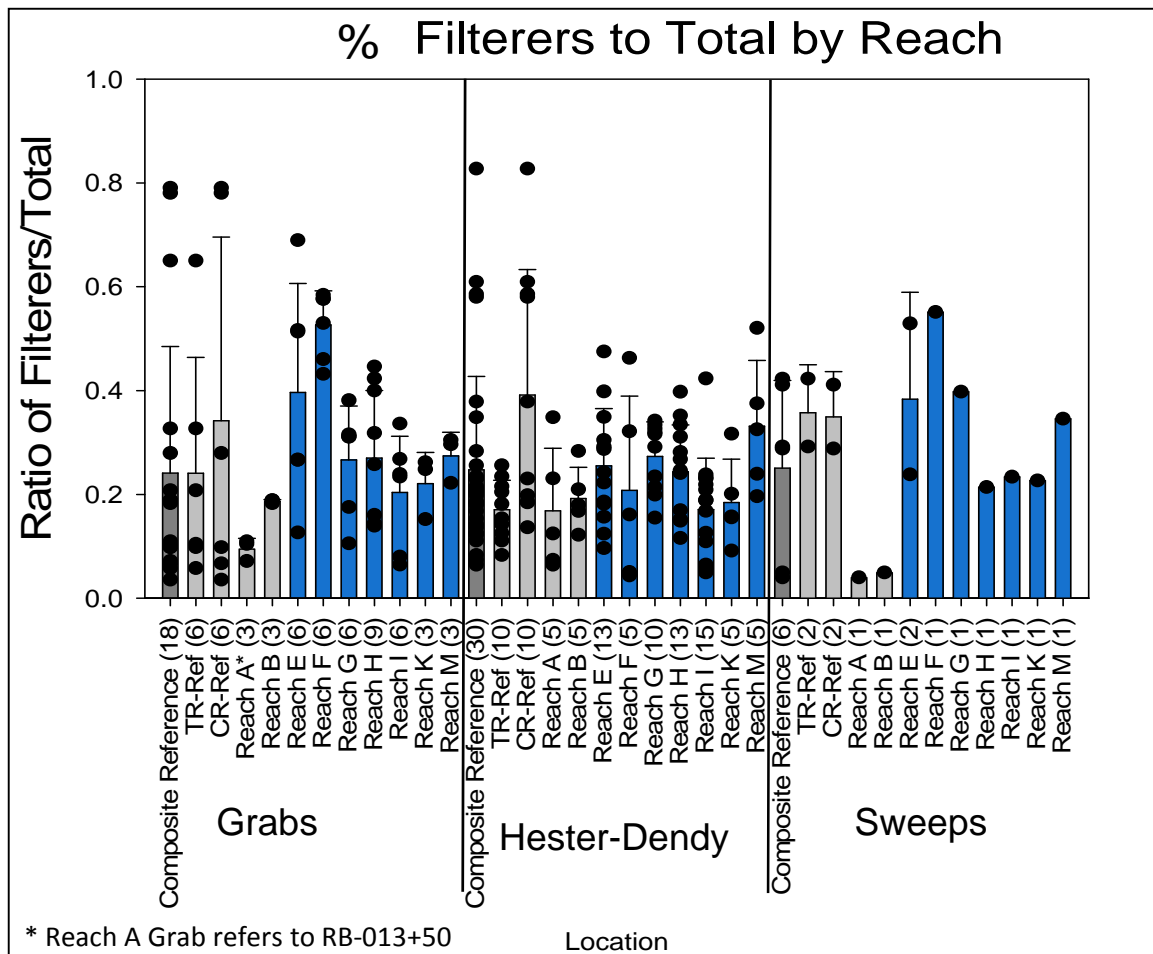
- Bars/whiskers reflect the mean and one standard deviation for the replicates in each sample.
- Replicates as follows: Hester-Dendy = 5; grabs = 3, sweeps = 1.
- Circles reflect the individual replicate result. Note that some circles may overlap.
- Replicate counts are provided as numbers in parentheses along the x-axis labels.
- HD = Hester-Dendy

References Areas:

- TR = Tittabawassee River
- CR = Chippewa River
- Reaches A & B

- The HBI results are generally comparable among locations and sample types, with a potential exception being the HD samples.
- In the HD samples, the TR-Ref has the lowest values, and therefore, the highest quality condition. All other locations in the CR-Ref and Segment 1 scored slightly higher. Reaches H and I have the highest HD HBI values but are within the range seen in the CR-Ref and Reaches A and B.
- The HBI scale is from 0 to 10, with 10 reflecting degraded conditions, such as those related to municipal sewage treatment. Values in the intermediate range seen at all locations does not suggest degraded conditions and do not point to any particular degradation patterns.





Notes:

- The ratio of filterers to total organisms provides insight into functional feeding group composition.
- Higher values generally reflect higher quality conditions.

Graphing:

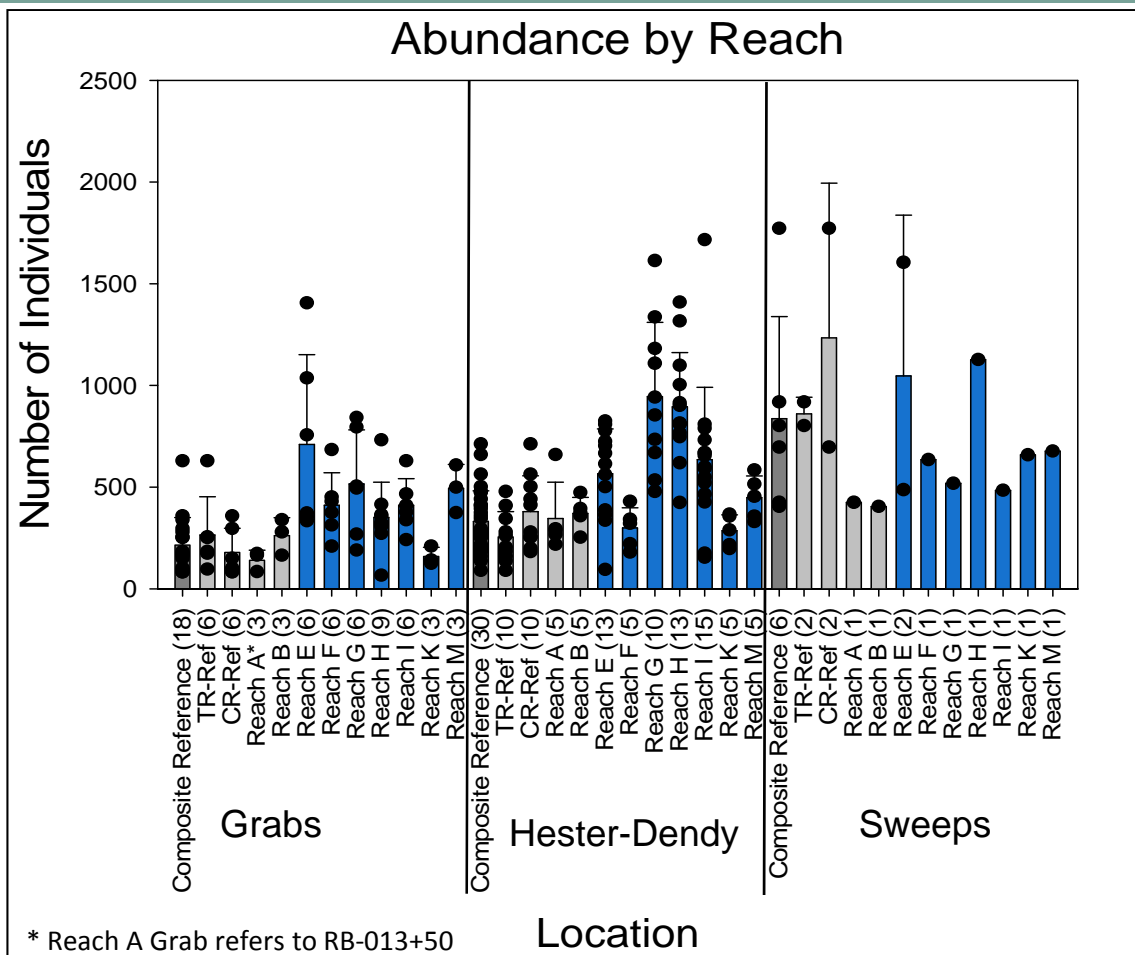
- Bars/whiskers reflect the mean and one standard deviation for the replicates in each sample.
- Circles reflect the individual replicate result. Note that some circles may overlap.
- Replicate counts are provided as numbers in parentheses along the x-axis labels.
- Replicates as follows: Hester-Dendy = 5; grabs = 3, sweeps = 1.

References Areas:

- TR = Tittabawassee River
- CR = Chippewa River
- Reaches A & B

- The percent filterers are comparable among locations except that Reaches A and B show the lowest values in both grab and sweep samples. These results are consistent with the higher percent of surface dependent species at these locations. It is unclear if habitat constraints or the presence of stormwater outfalls in the vicinity of these locations are the cause of these community results.





Notes:

- Abundance is a metric that is inherently considered as part of many other metrics (e.g., percent dominance).
- Higher values indicate greater abundance, which may or may not reflect higher quality conditions.

Graphing:

- Bars/whiskers reflect the mean and one standard deviation for the replicates in each sample.
- Circles reflect the individual replicate result. Note that some circles may overlap.
- Replicate counts are provided as numbers in parentheses along the x-axis labels.
- Replicates as follows: Hester-Dendy = 5; grabs = 3, sweeps = 1.

References Areas:

- TR = Tittabawassee River
- CR = Chippewa River
- Reaches A & B

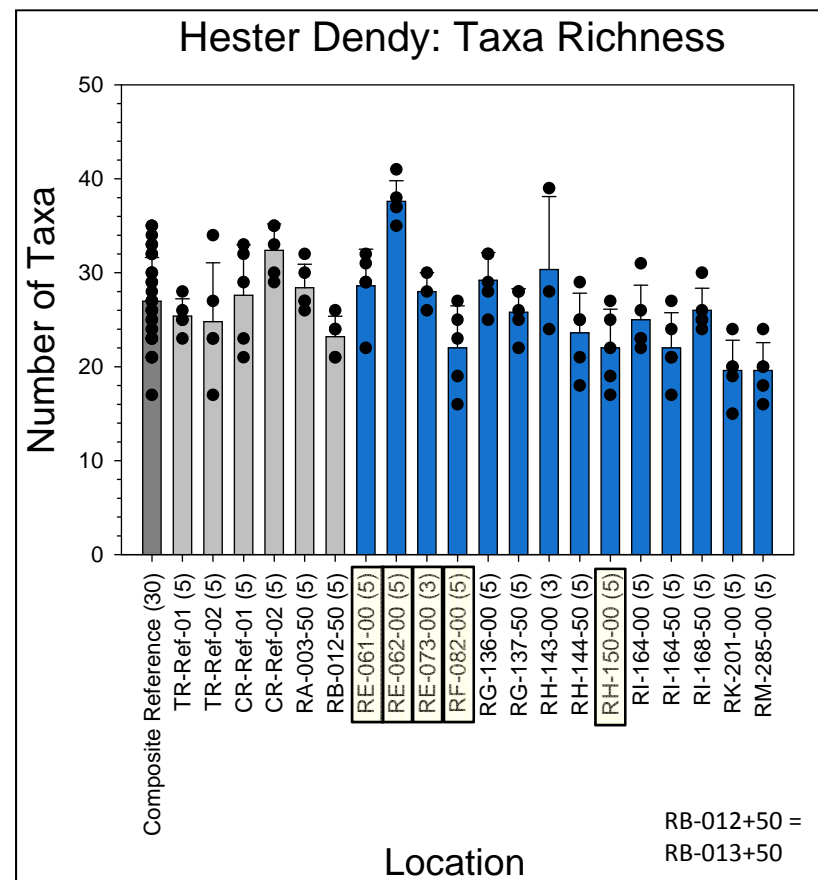
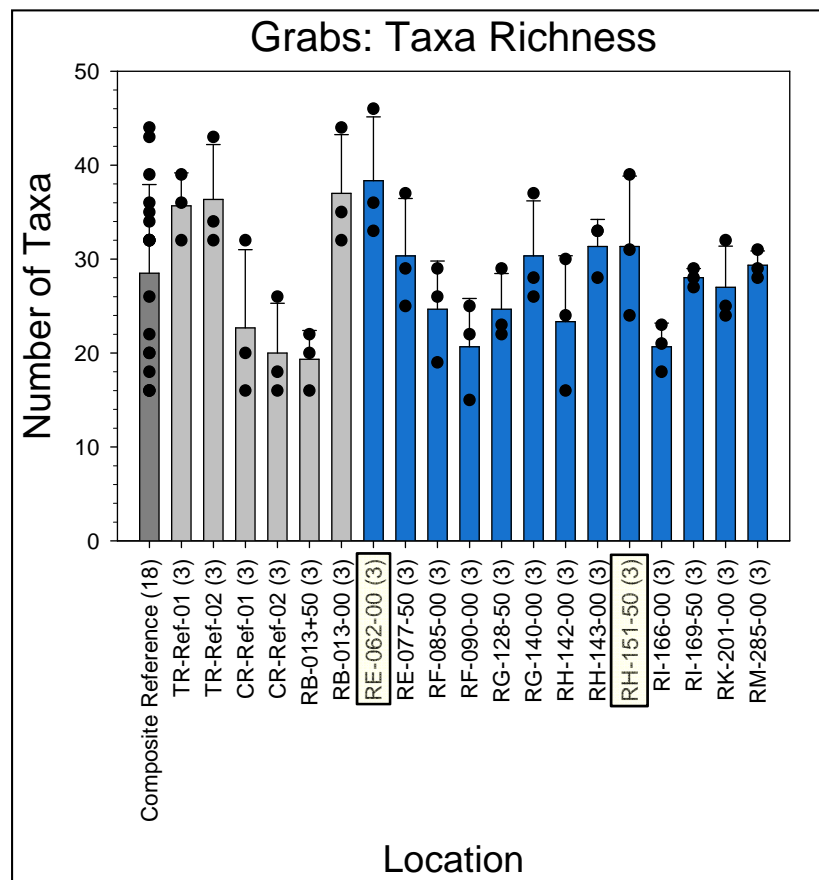
- Abundance is a simple count of organisms and this metric alone does not indicate whether conditions are good or degraded unless high numbers of pollution tolerant species are seen.
- Reaches H and I have some of the highest abundance with Hester-Dendy samples, and these samples were dominated by the tolerant midge (*Rheotanytarsus sp.*) and the worm (*Nais sp.*).
- CR-Ref sweep results also show high abundance and Table 4-2c shows that these are dominated by amphipods and caddisflies, which are generally considered pollution sensitive. Reach E grabs show the highest abundance of this sample type and they were dominated by caddisflies, midge, and naiad worms, which are both pollution sensitive and pollution tolerant (Table 4-2a).



Reach Metric Results: Abundance

Benthic Community Assessment Report

Figure
4-11

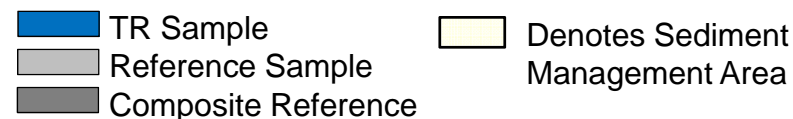


Notes:

- Number of taxa reflects community diversity; higher values reflect higher quality conditions. There are no remarkable patterns within SMAs.

Graphing:

- Bars/whiskers reflect the mean and one standard deviation for the replicates in each sample.
- Replicates as follows: HDs = 5; grabs = 3, sweeps = 1.
- Circles reflect the individual replicate result. Note that some circles may overlap.
- Replicate counts are provided as numbers in parentheses along the x-axis labels.



Reference Areas:

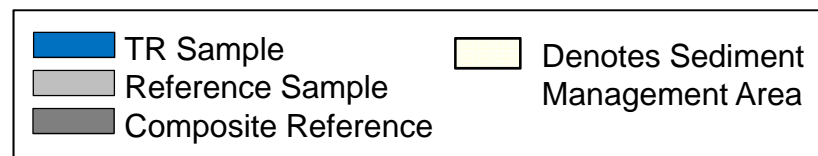
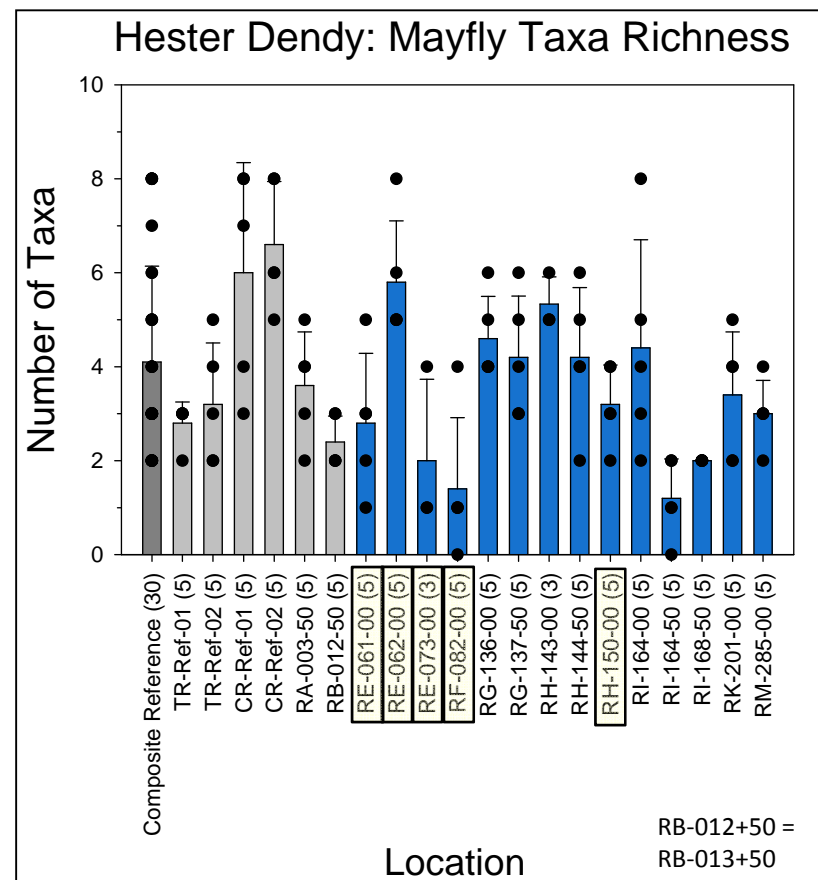
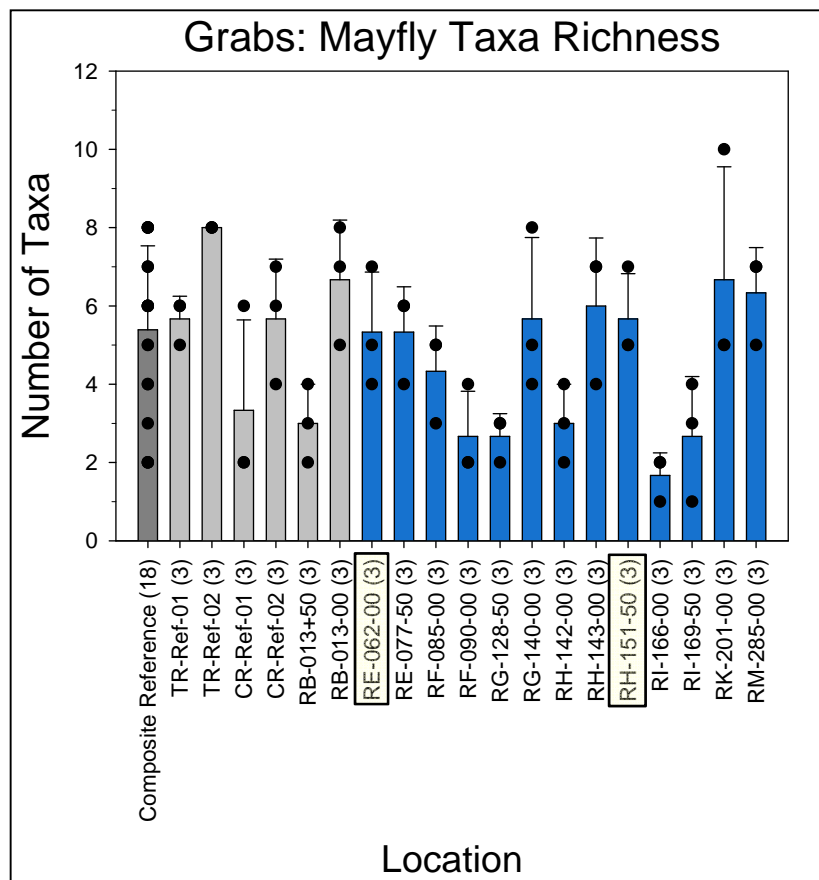
- TR = Tittabawassee River
- CR = Chippewa River
- Reaches A & B

Location-Specific Metric Results: Taxa Richness

Benthic Community Assessment Report

Figure
4-2a





Notes:

- Mayflies are pollution sensitive. Higher values indicate higher quality conditions. There are no remarkable patterns within SMAs.

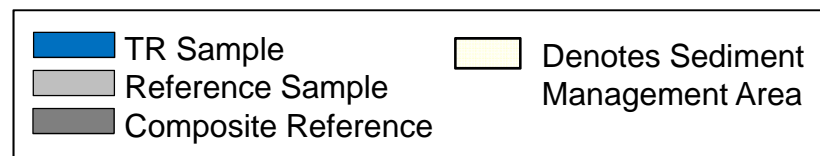
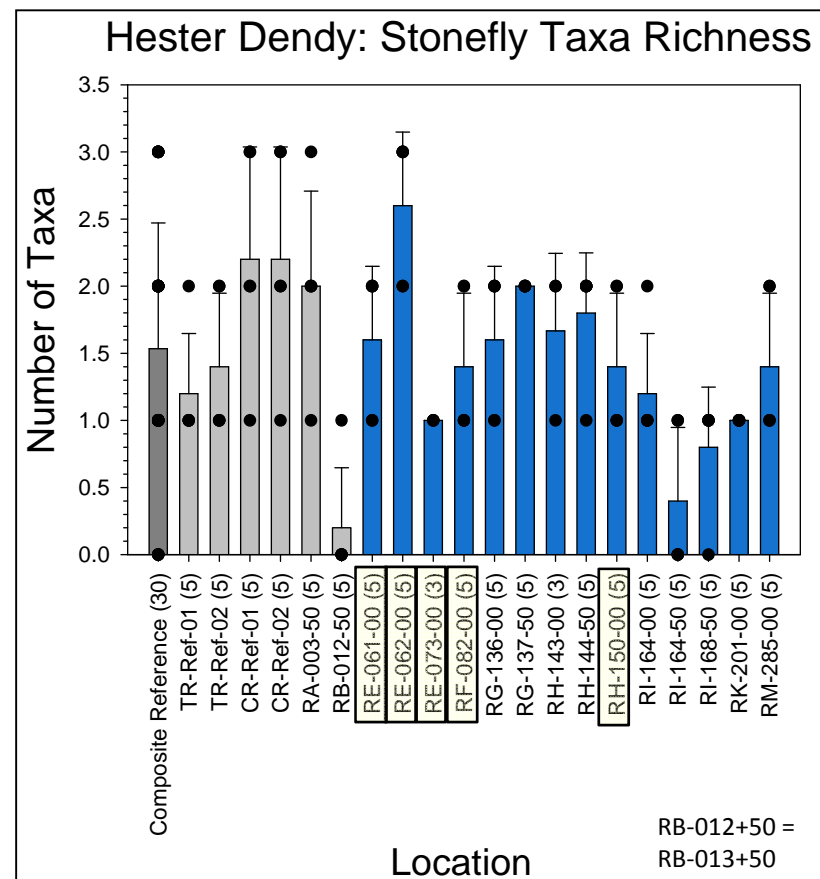
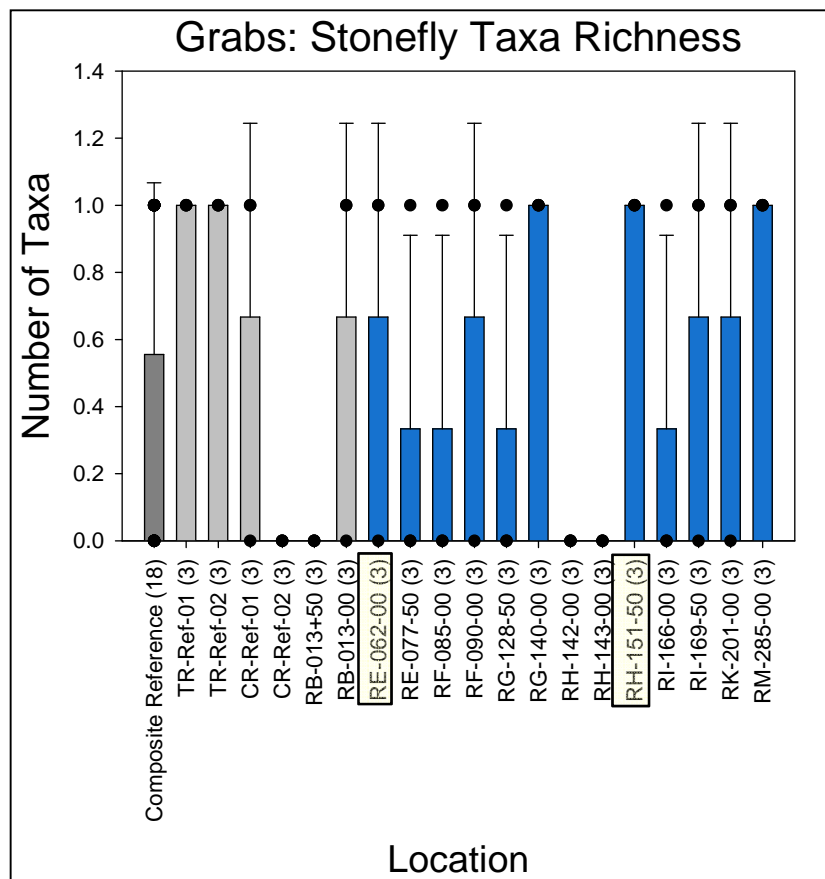
Graphing:

- Bars/whiskers reflect the mean and one standard deviation for the replicates in each sample.
- Replicates as follows: HDs = 5; grabs = 3, sweeps = 1.
- Circles reflect the individual replicate result. Note that some circles may overlap.
- Replicate counts are provided as numbers in parentheses along the x-axis labels.

Reference Areas:

- TR = Tittabawassee River
- CR = Chippewa River
- Reaches A & B





Notes:

- Stoneflies are pollution sensitive. Higher values indicate higher quality conditions. There are no remarkable patterns within SMAs.

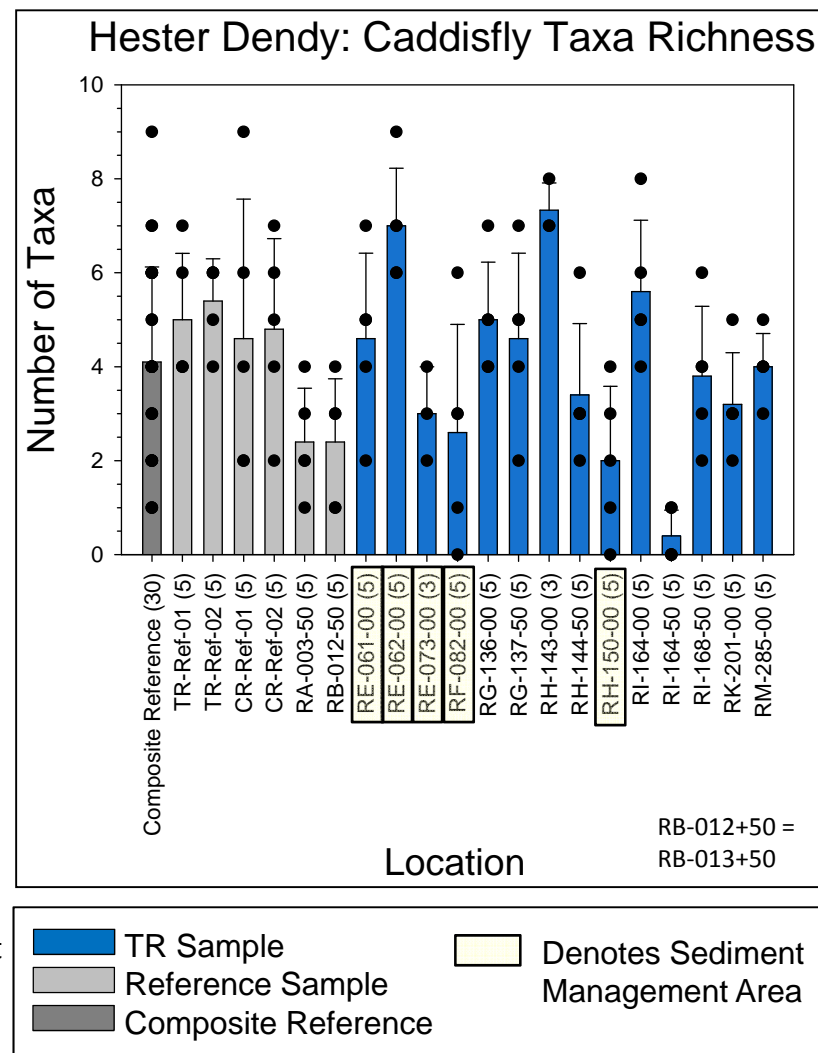
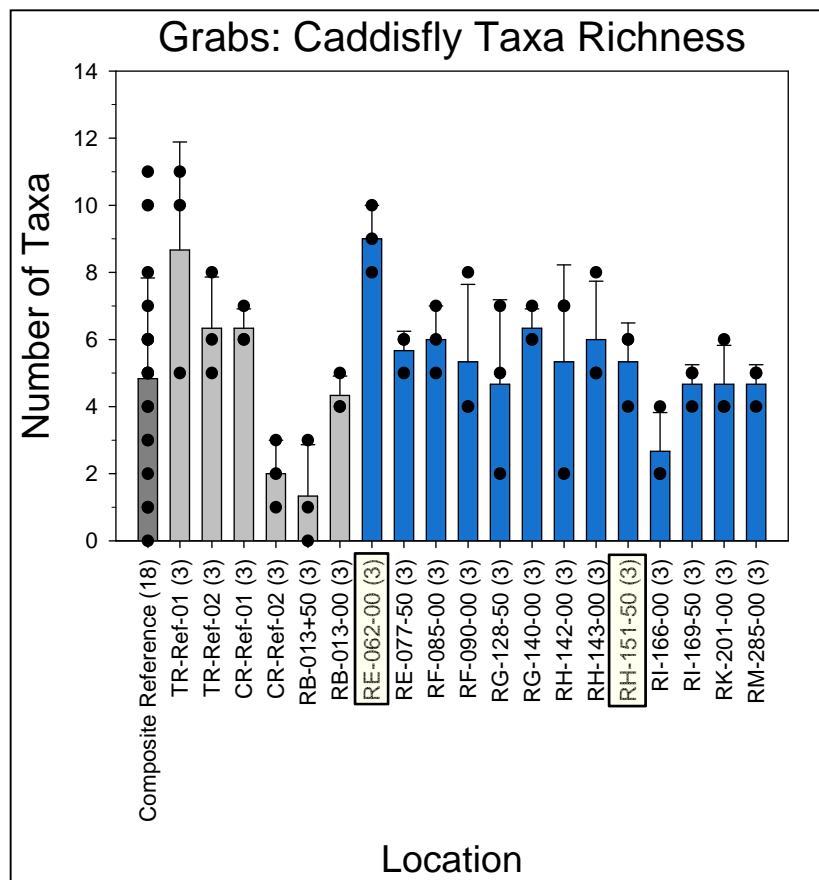
Graphing:

- Bars/whiskers reflect the mean and one standard deviation for the replicates in each sample.
- Replicates as follows: HDs = 5; grabs = 3, sweeps = 1.
- Circles reflect the individual replicate result. Note that some circles may overlap.
- Replicate counts are provided as numbers in parentheses along the x-axis labels.

Reference Areas:

- TR = Tittabawassee River
- CR = Chippewa River
- Reaches A & B





Notes:

- Caddisflies are also considered pollution sensitive. Higher values represent higher quality conditions. There are no remarkable patterns within SMAs.

Graphing:

- Bars/whiskers reflect the mean and one standard deviation for the replicates in each sample.
- Replicates as follows: HDs = 5; grabs = 3, sweeps = 1.
- Circles reflect the individual replicate result. Note that some circles may overlap.
- Replicate counts are provided as numbers in parentheses along the x-axis labels.

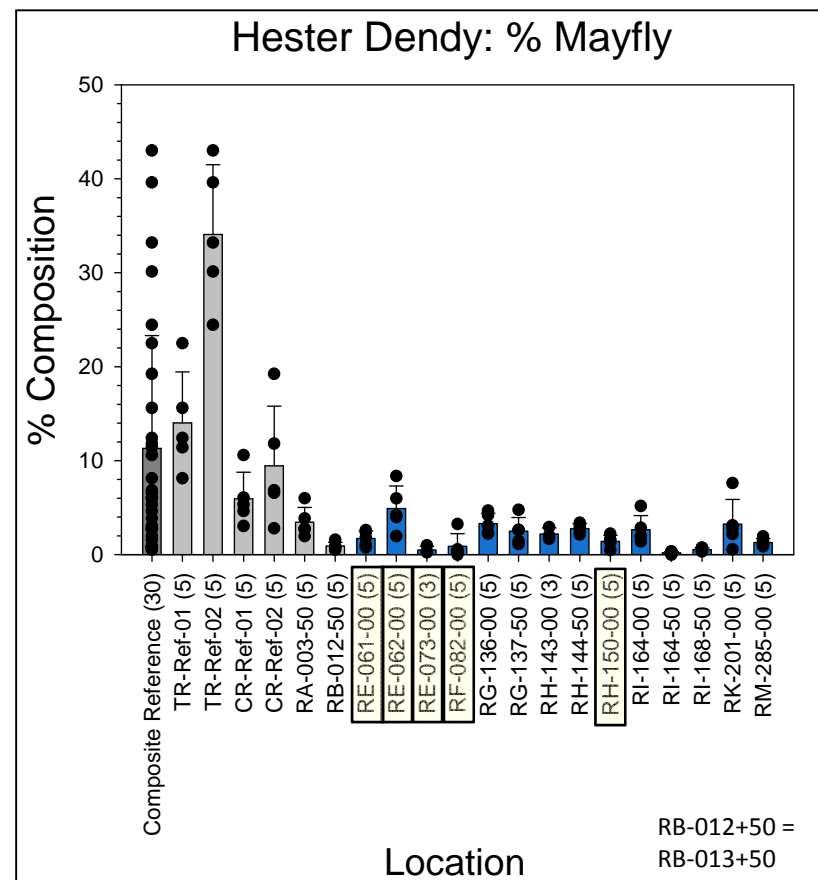
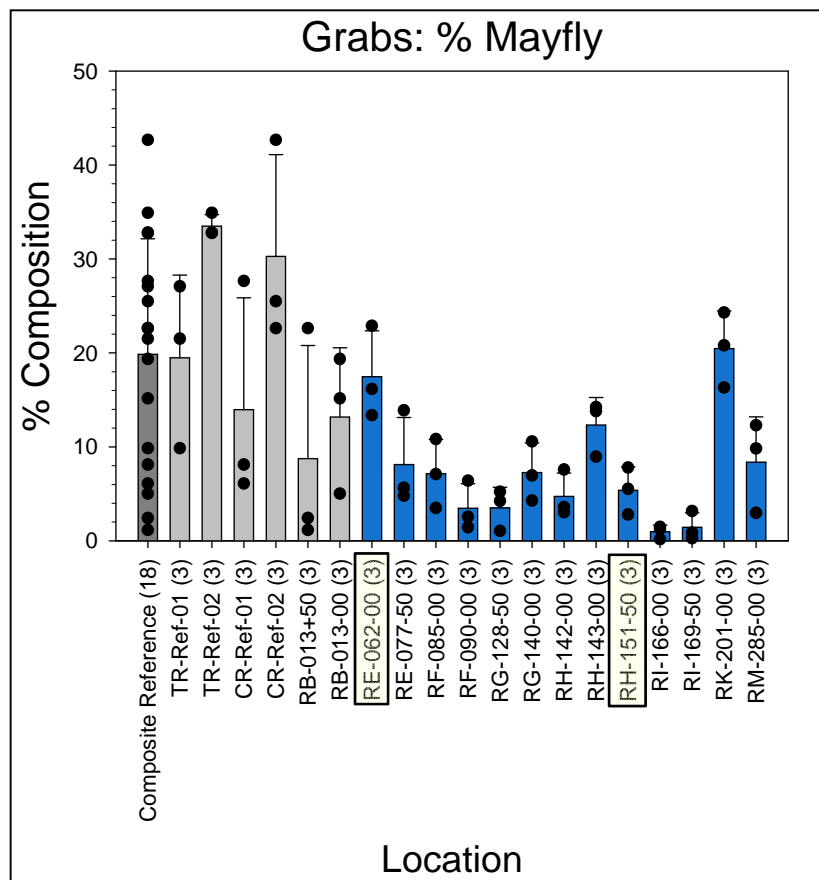
Reference Areas:

- TR = Tittabawassee River
- CR = Chippewa River
- Reaches A & B

Location-Specific Metric Results:
Total Number of Caddisfly Taxa
 Benthic Community Assessment Report

Figure
4-2d



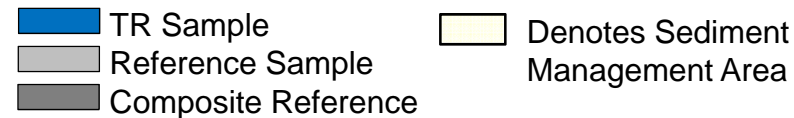


Notes:

- Mayflies are pollution sensitive. Higher values indicate higher quality conditions. There are no remarkable patterns within SMAs.

Graphing:

- Bars/whiskers reflect the mean and one standard deviation for the replicates in each sample.
- Replicates as follows: HDs = 5; grabs = 3, sweeps = 1.
- Circles reflect the individual replicate result. Note that some circles may overlap.
- Replicate counts are provided as numbers in parentheses along the x-axis labels.



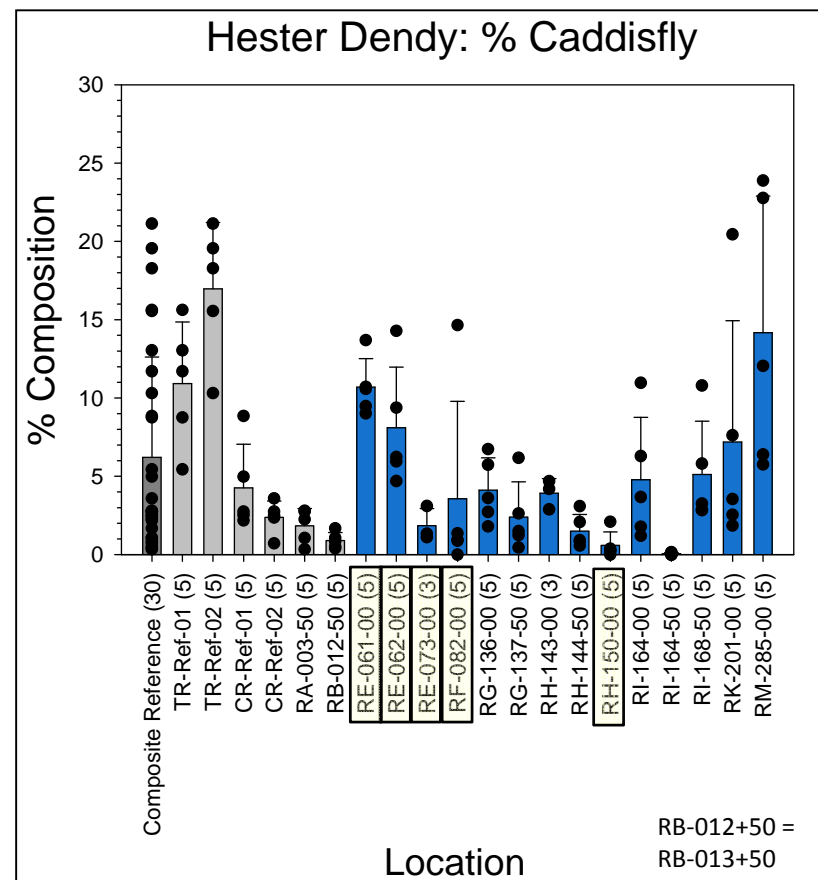
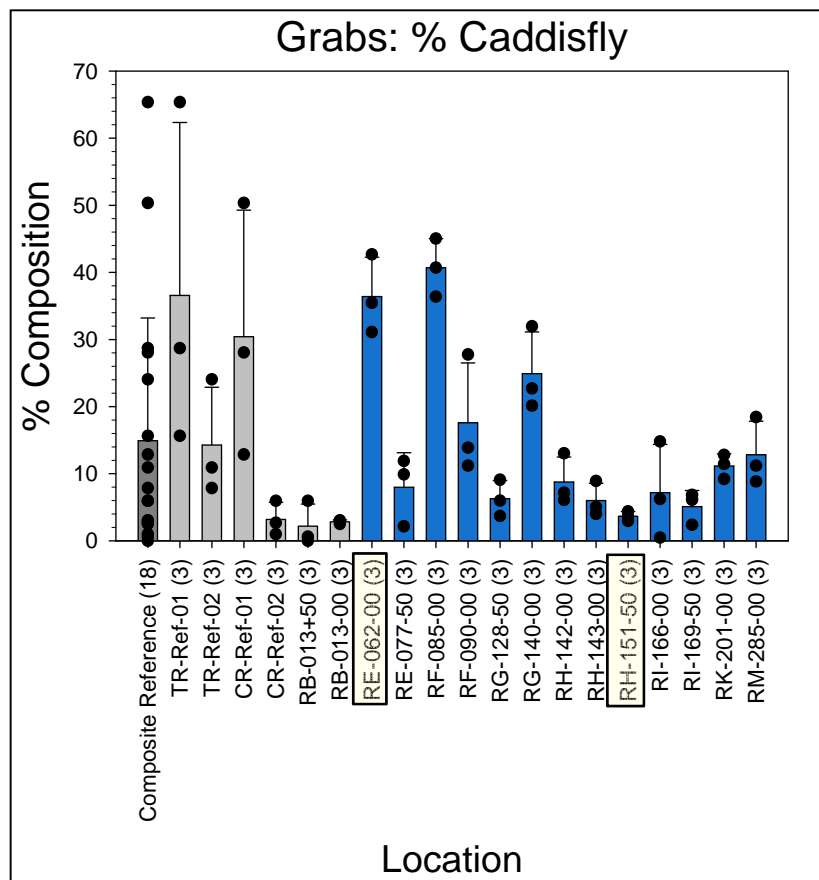
Reference Areas:

- TR = Tittabawassee River
- CR = Chippewa River
- Reaches A & B

Location-Specific Metric Results:
Percent Mayfly Composition
Benthic Community Assessment Report

Figure
4-2e





Notes:

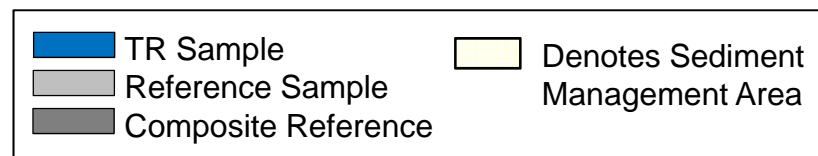
- Caddisflies are generally pollution sensitive. Higher values indicate higher quality conditions. There are no remarkable patterns within SMAs.

Graphing:

- Bars/whiskers reflect the mean and one standard deviation for the replicates in each sample.
- Replicates as follows: HDs = 5; grabs = 3, sweeps = 1.
- Circles reflect the individual replicate result. Note that some circles may overlap.
- Replicate counts are provided as numbers in parentheses along the x-axis labels.

Reference Areas:

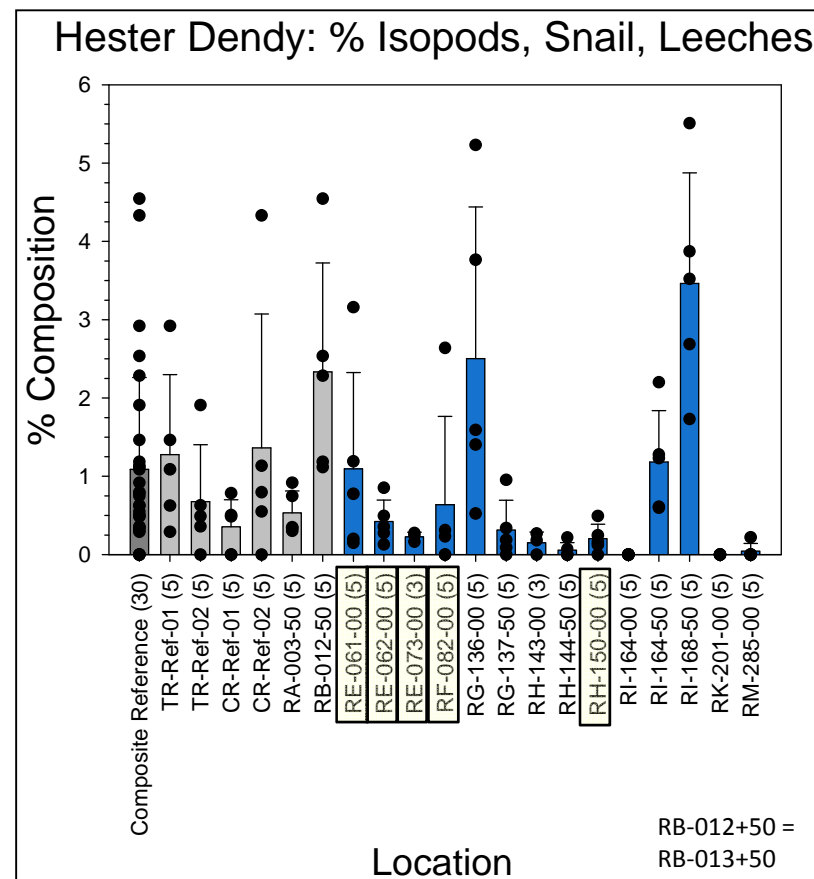
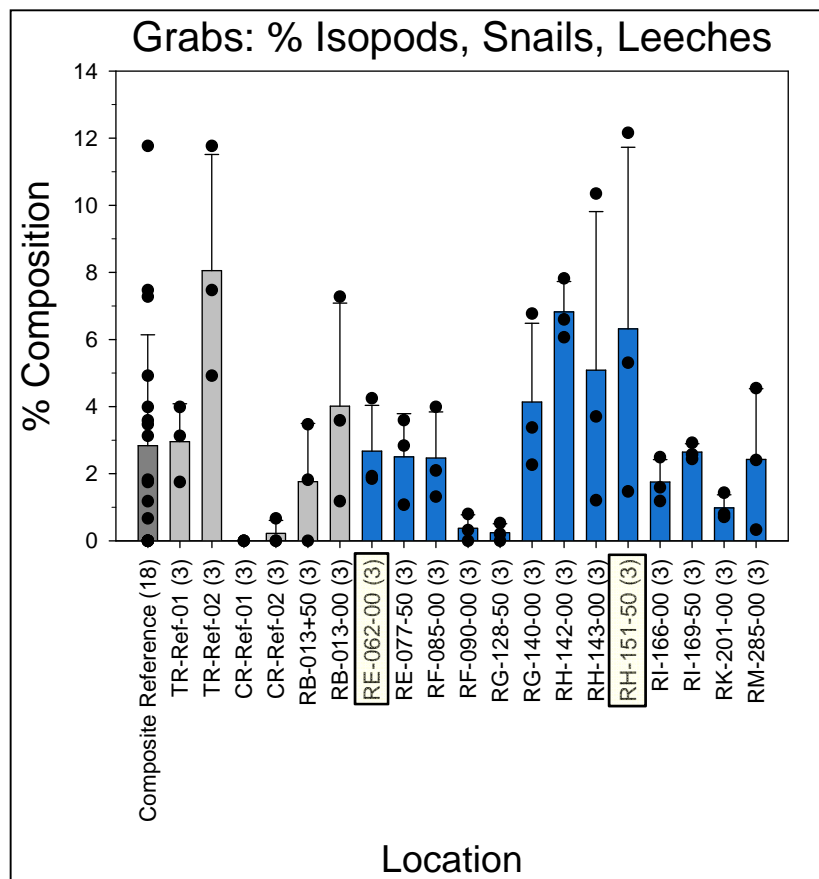
- TR = Tittabawassee River
- CR = Chippewa River
- Reaches A & B



Location-Specific Metric Results:
Percent Caddisfly Composition
 Benthic Community Assessment Report

Figure
4-2f





Notes:

- These 3 taxa can give an indication of the severity of environmental perturbation. Higher values may indicate lower quality conditions (when > 25%). There are no remarkable patterns within SMAs.

Graphing:

- Bars/whiskers reflect the mean and one standard deviation for the replicates in each sample.
- Replicates as follows: HDs = 5; grabs = 3, sweeps = 1.
- Circles reflect the individual replicate result. Note that some circles may overlap.
- Replicate counts are provided as numbers in parentheses along the x-axis labels.

Reference Areas:

- TR = Tittabawassee River
- CR = Chippewa River
- Reaches A & B

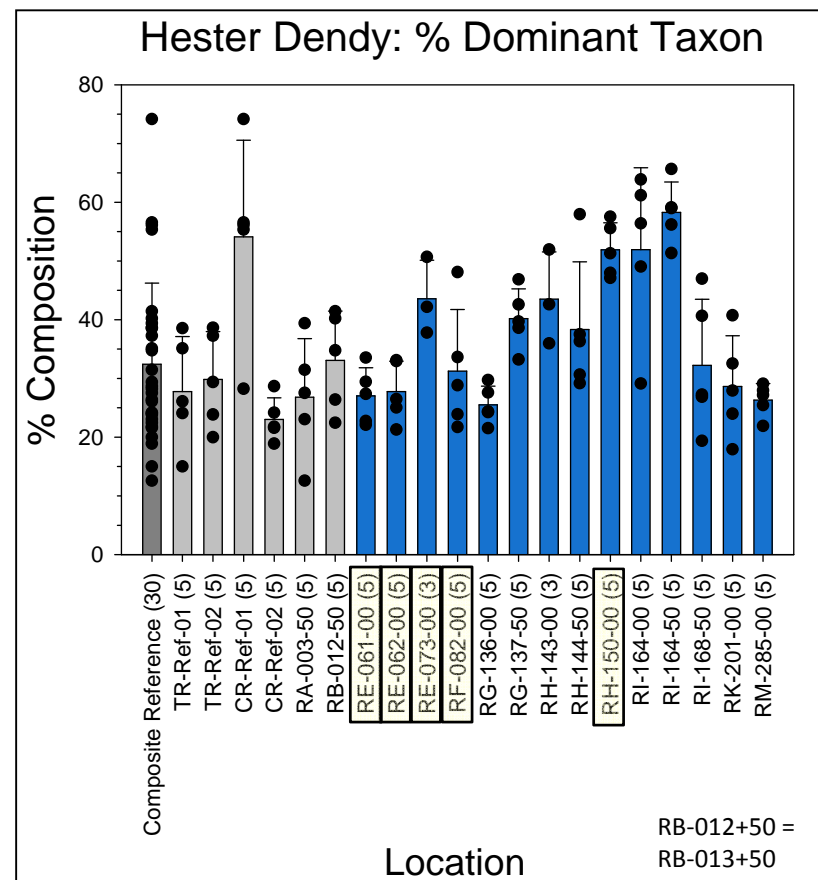
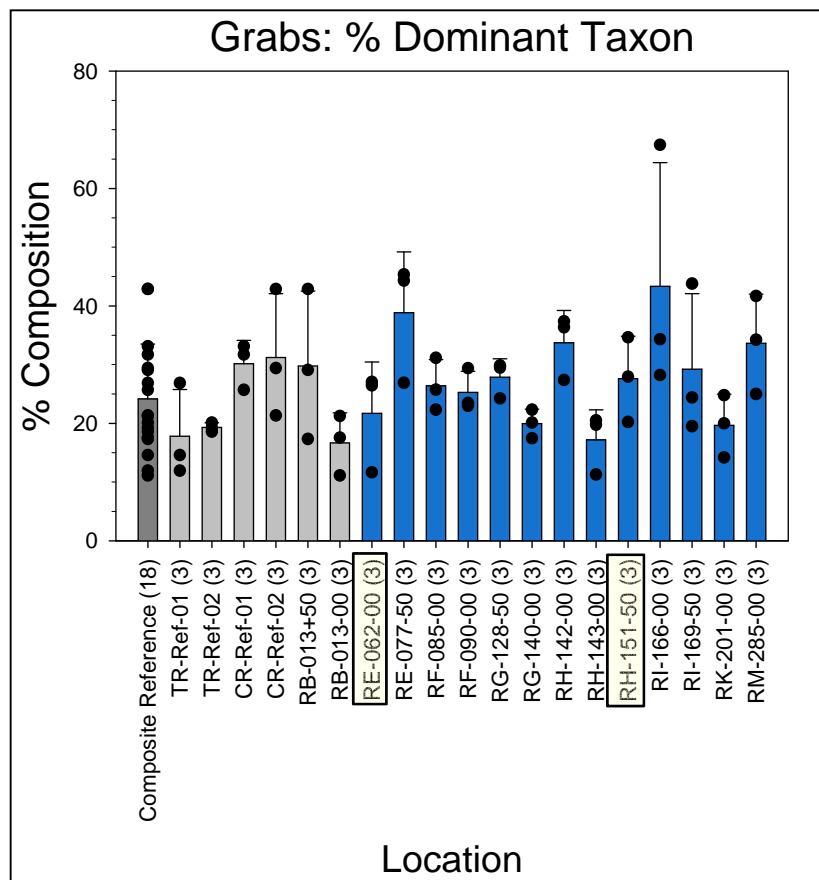
- TR Sample
- Reference Sample
- Composite Reference
- Denotes Sediment Management Area



Location-Specific Metric Results: Percent Isopods, Snails, and Leeches

Benthic Community Assessment Report

Figure
4-2g

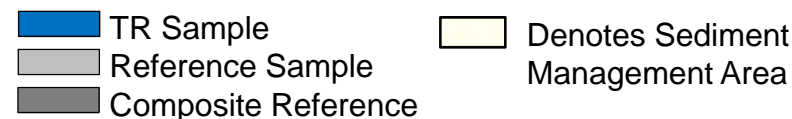


Notes:

- The abundance of the numerically dominant taxon is an indication of community balance. Higher values indicate lower quality conditions.
- There are no remarkable patterns within SMAs.

Graphing:

- Bars/whiskers reflect the mean and one standard deviation for the replicates in each sample.
- Replicates as follows: HDs = 5; grabs = 3, sweeps = 1.
- Circles reflect the individual replicate result. Note that some circles may overlap.



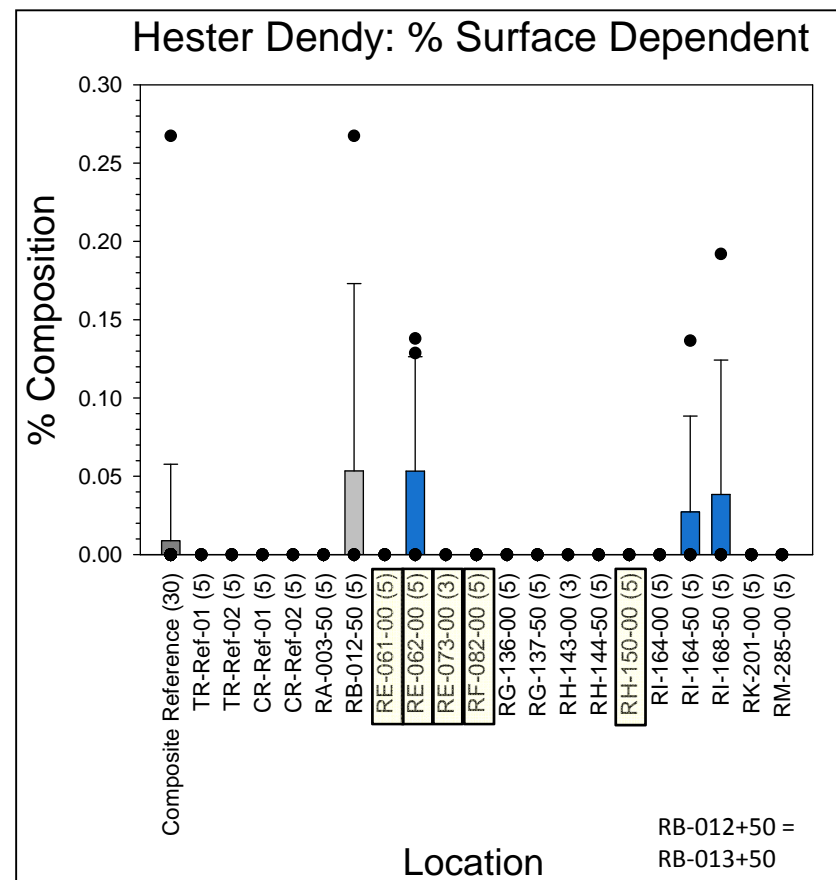
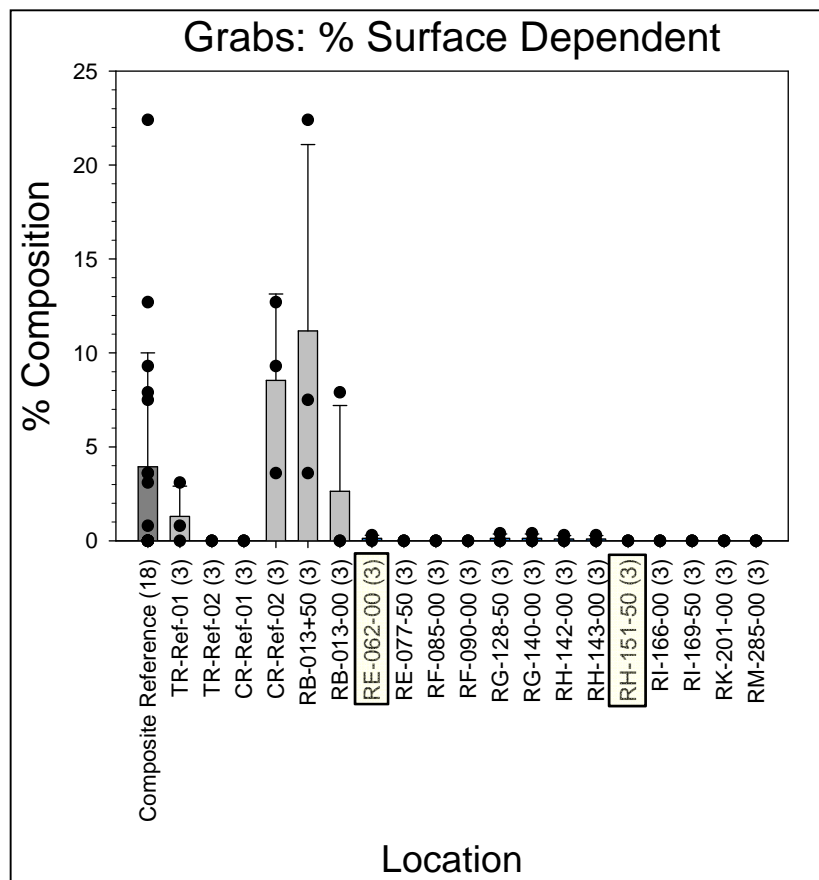
Reference Areas:

- TR = Tittabawassee River
- CR = Chippewa River
- Reaches A & B

Location-Specific Metric Results:
Percent Dominant Taxon
 Benthic Community Assessment Report

Figure
4-2h





Notes:

- High percentages may indicate shifts in dissolved oxygen.
- Higher values may indicate lower quality conditions (when > 25%).
- There are no remarkable patterns within SMAs.

Graphing:

- Bars/whiskers reflect the mean and one standard deviation for the replicates in each sample.
- Replicates as follows: HDs = 5; grabs = 3, sweeps = 1.
- Circles reflect the individual replicate result. Note that some circles may overlap.

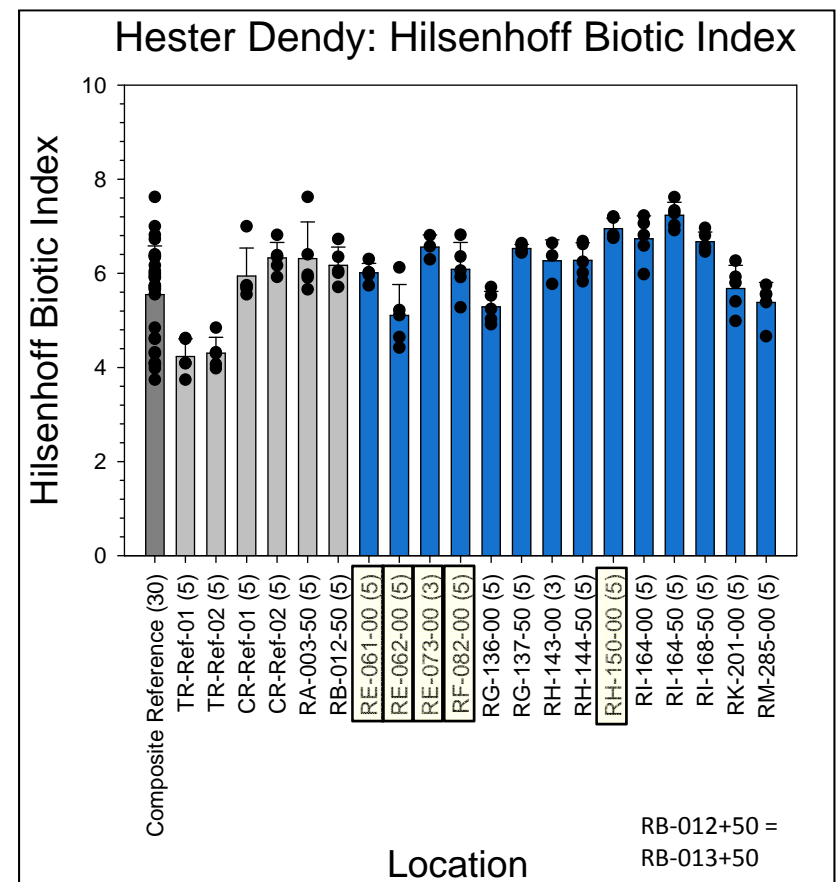
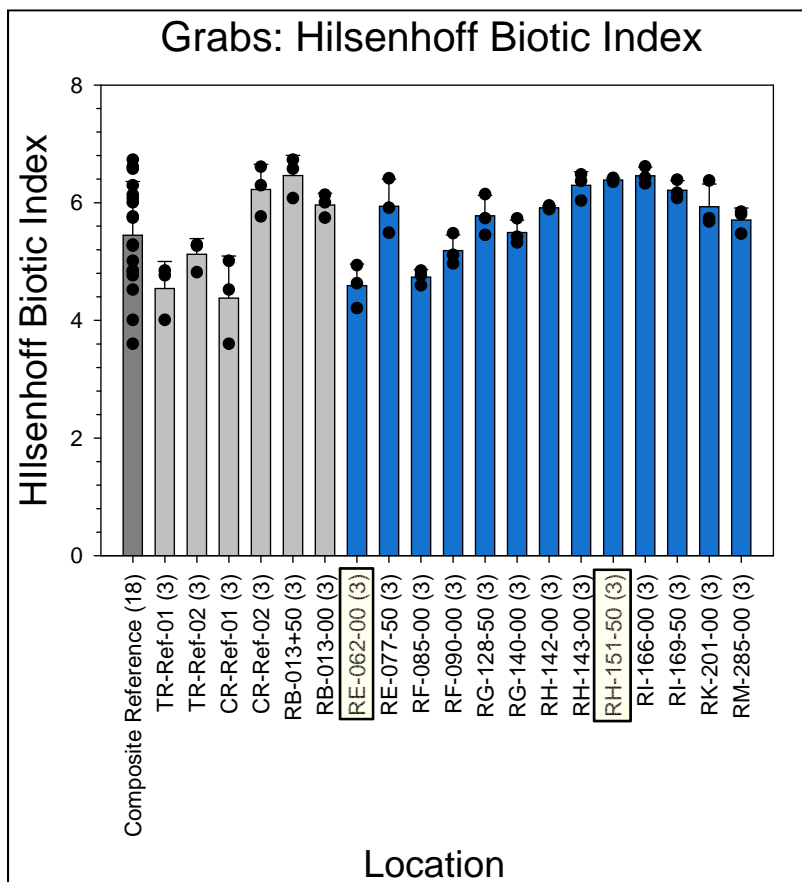
Reference Areas:

- TR = Tittabawassee River
- CR = Chippewa River
- Reaches A & B

Location-Specific Metric Results:
Percent Surface Dependent
 Benthic Community Assessment Report

Figure
4-2i





Notes:

- HBI provides insight into municipal or treated wastewater shifts in community structure. Higher values generally reflect lower quality conditions. There are no remarkable patterns within SMAs.

Graphing:

- Bars/whiskers reflect the mean and one standard deviation for the replicates in each sample.
- Replicates as follows: HDs = 5; grabs = 3, sweeps = 1.
- Circles reflect the individual replicate result. Note that some circles may overlap.
- Replicate counts are provided as numbers in parentheses along the x-axis labels.

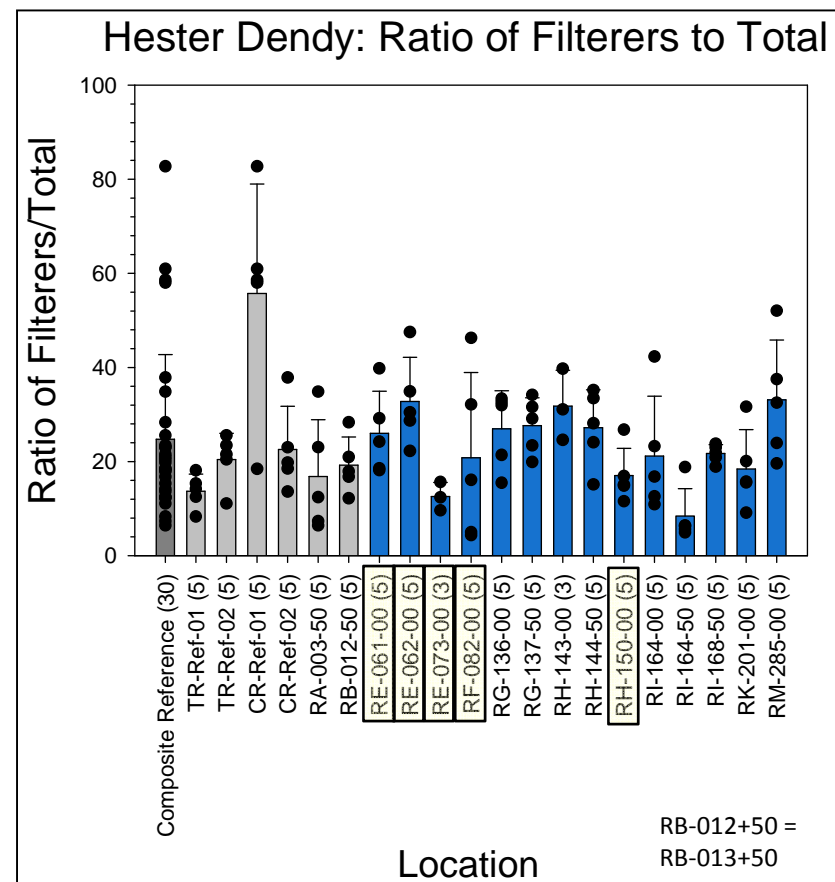
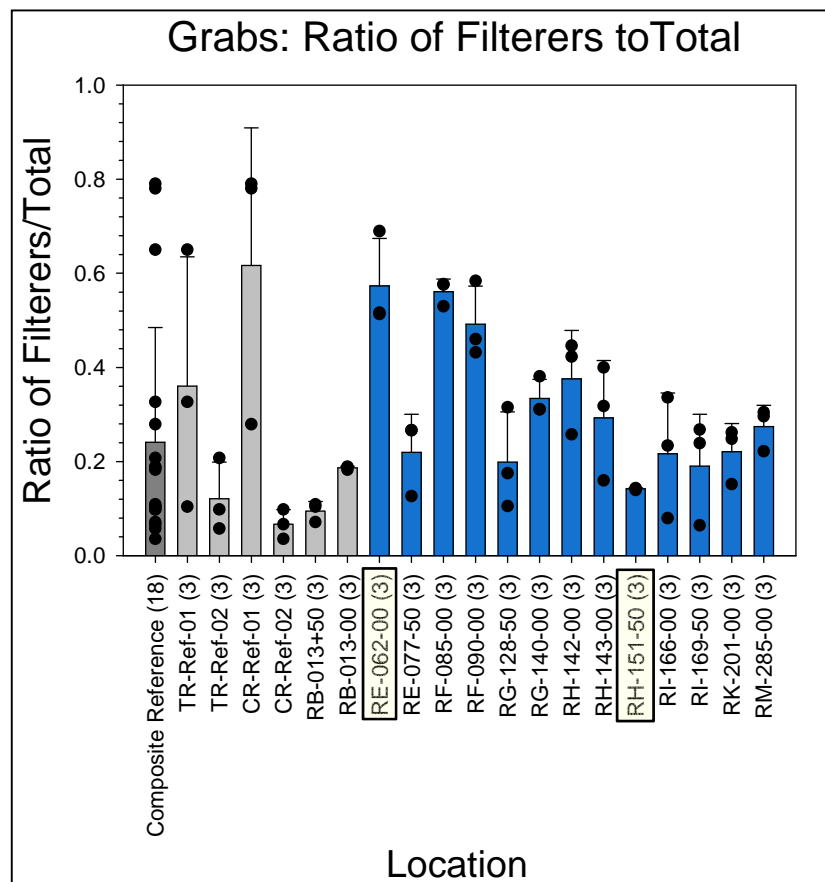
Reference Areas:

- TR = Tittabawassee River
- CR = Chippewa River
- Reaches A & B

Location-Specific Metric Results:
Hilsenhoff Biotic Index
 Benthic Community Assessment Report

Figure
4-2j





Notes:

- The ratio of filterers to total organisms provides insight into functional feeding group composition. Higher values generally reflect higher quality conditions. There are no remarkable patterns within SMAs.

Graphing:

- Bars/whiskers reflect the mean and one standard deviation for the replicates in each sample.
- Replicates as follows: HDs = 5; grabs = 3, sweeps = 1.
- Circles reflect the individual replicate result. Note that some circles may overlap.
- Replicate counts are provided as numbers in parentheses along the x-axis labels.

Reference Areas:

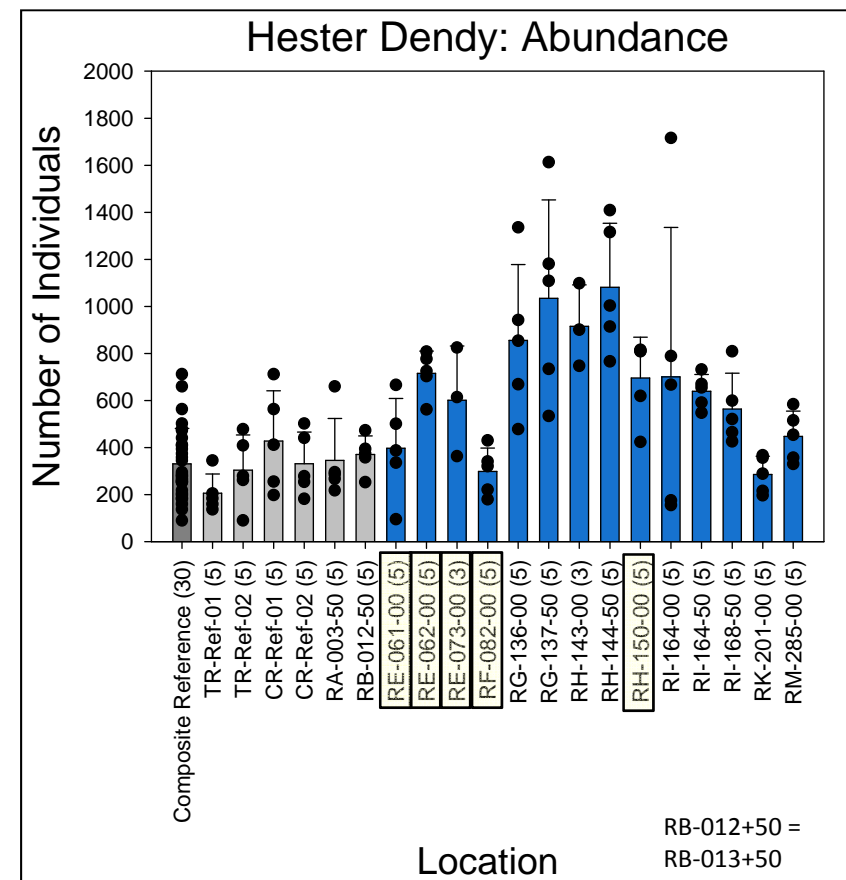
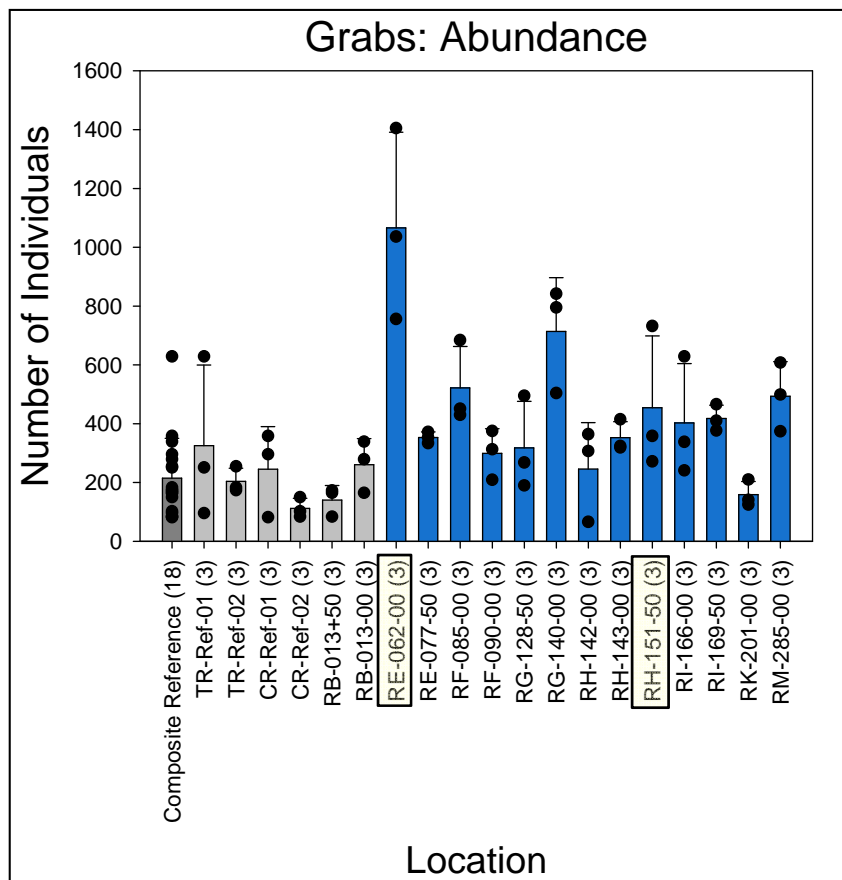
- TR = Tittabawassee River
- CR = Chippewa River
- Reaches A & B

Location-Specific Metric Results: Percent Filterers

Benthic Community Assessment Report

Figure
4-2k





Notes:

- Abundance is a simple count of organisms present. Higher values may or may not reflect higher quality conditions. There are no remarkable patterns within SMAs.

Graphing:

- Bars/whiskers reflect the mean and one standard deviation for the replicates in each sample.
- Replicates as follows: HDs = 5; grabs = 3, sweeps = 1.
- Circles reflect the individual replicate result. Note that some circles may overlap.

- TR Sample
- Reference Sample
- Composite Reference
- Denotes Sediment Management Area

Reference Areas:

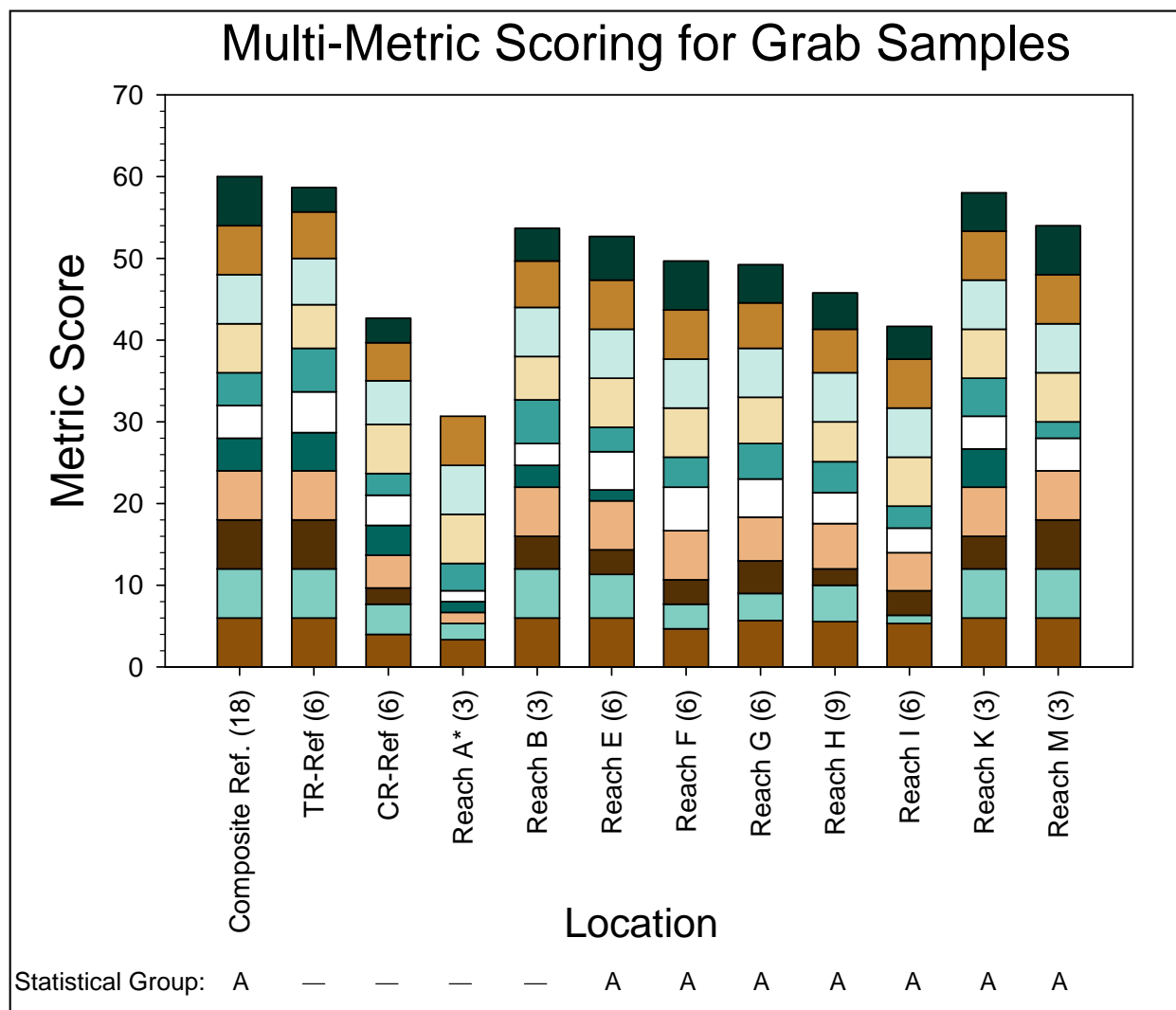
- TR = Tittabawassee River
- CR = Chippewa River
- Reaches A & B



Location-Specific Metric Results: Abundance

Benthic Community Assessment Report

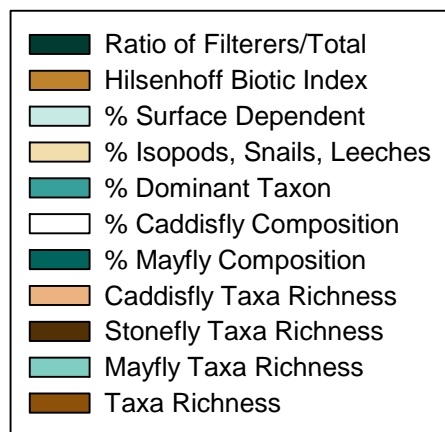
Figure
4-2I



* Reach A refers to RB-013+50

Notes:

- This graphic presents the EPA multi-metric scoring, with detailed insight into the specific metrics that are the basis of the composite reference and how each Reach compares to that composite reference.
- Statistical Group:
 - “A” denotes locations that are statistically similar to the composite reference.
 - -- denotes statistical comparison not conducted.
 - Results show that there are no statistically significant differences between the Reaches and the composite reference.

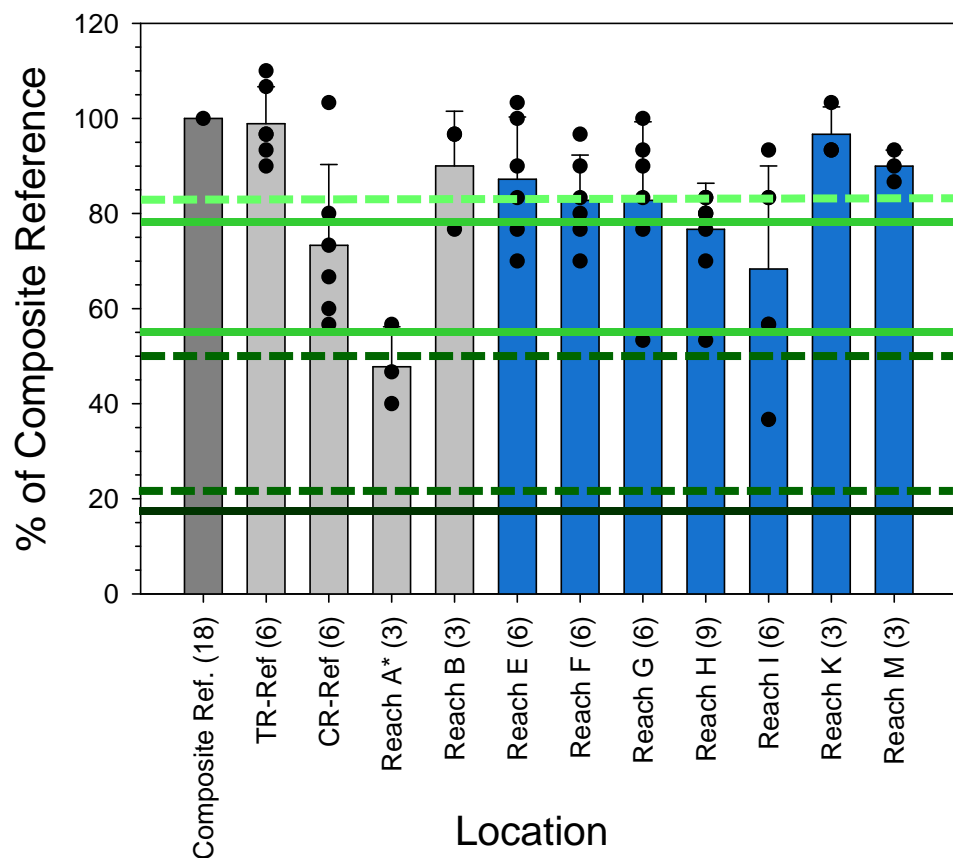


EPA Multi-Metric Scoring for Grab Compared to Composite Reference: Reaches

Benthic Community Assessment Report

Figure
4-3a

Biological Condition Score for Grab Samples



Statistical Group: A — — — — A A A A A A A

EPA Impairment Status Thresholds (a)

- Non (>83%)
- Slight (55-79%)
- Moderate (21-50%)
- Severe (<18%)

- TR Sample
- Reference Sample
- Composite Reference

* Reach A refers to RB-013+50

Notes:

- This graphic reflects the same scoring data as Figure 4-3a, showing the EPA multi-metric scoring for each Reach for Grab samples.
- Scoring ranges that reflect the impairment status designations are illustrated by the horizontal lines and defined as follows in comparison to the composite reference:
 - Non = non-impaired
 - Slight = slight impairment
 - Moderate = moderate impairment
 - Severe = severe impairment
- These grab sample results show that most Reaches are considered non-impaired. Two Reaches (H and I) are considered slightly impaired based on the percent similarity with the composite reference.
- Statistical testing shows that Reaches E-M are not statistically different than the composite reference.
- The scoring for two references (CR-Ref and Reach RB-013+50) also show some impairment.

Graphing:

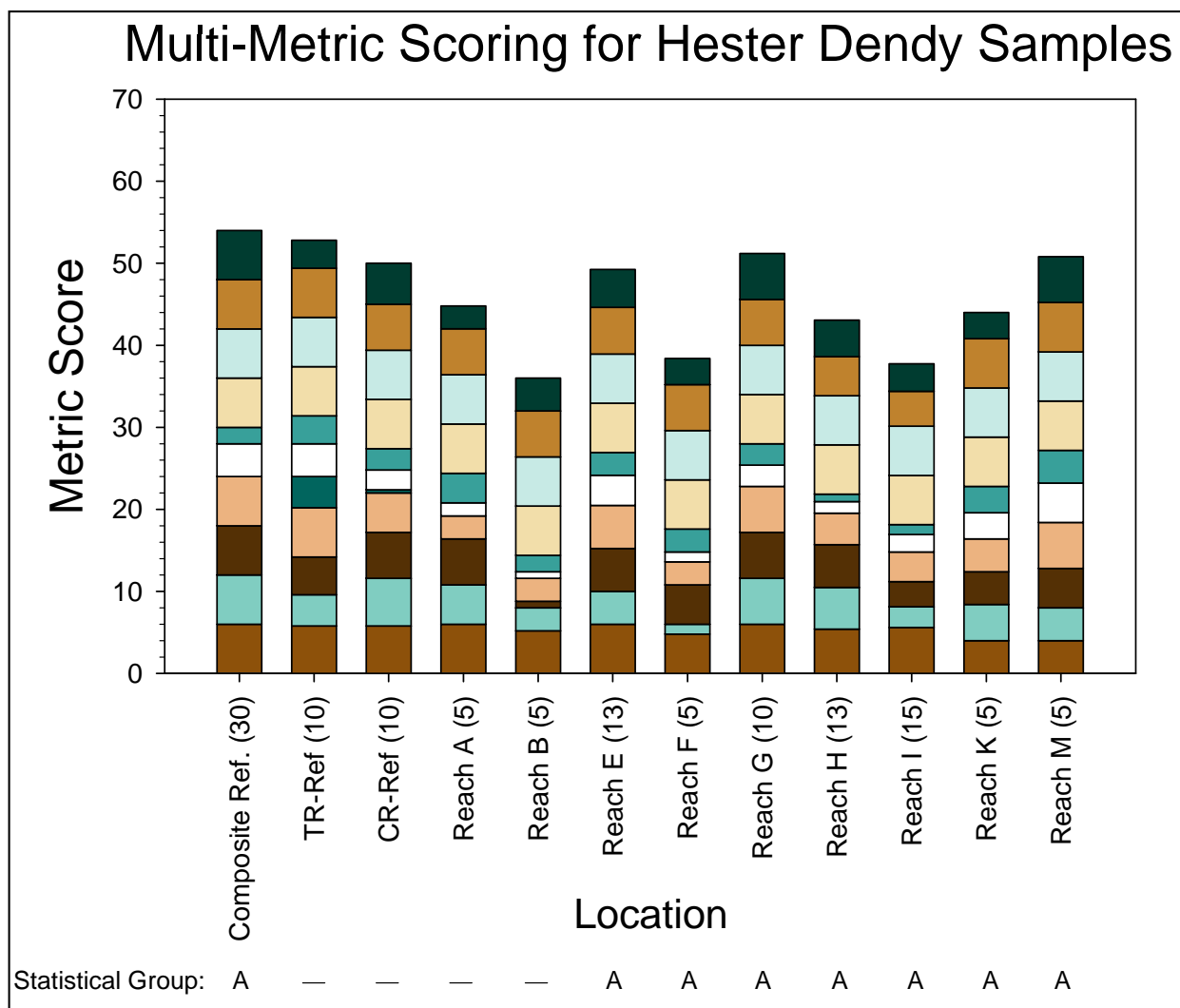
- Bars/whiskers reflect the mean and one standard deviation for the replicates in each sample.
- Replicates as follows: Hester-Dendy = 5; grabs = 3, sweeps = 1.
- Circles reflect the individual replicate result. Note that some circles may overlap.
- Replicate counts are provided as numbers in parentheses along the x-axis labels.
- Statistical Group: A denotes location similar to the composite reference, - denotes statistical comparison not conducted.



EPA Biological Condition Status for Grab Samples: Reaches

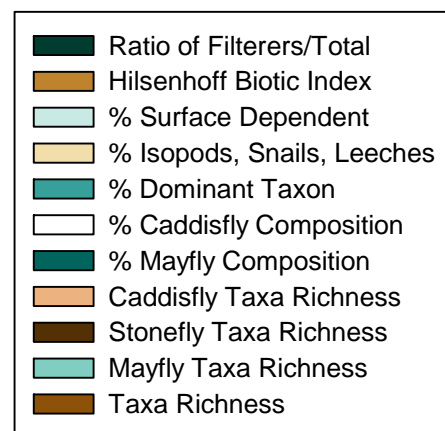
Benthic Community Assessment Report

Figure 4-3b



Notes:

- This graphic presents the EPA multi-metric scoring, with detailed insight into the specific metrics that are the basis of the composite reference and how each Reach compares to that composite reference.
- Statistical Group:
 - “A” denotes locations that are statistically similar to the composite reference.
 - -- denotes statistical comparison not conducted.
 - Results show that there are no statistically significant differences between the Reaches and the composite reference.

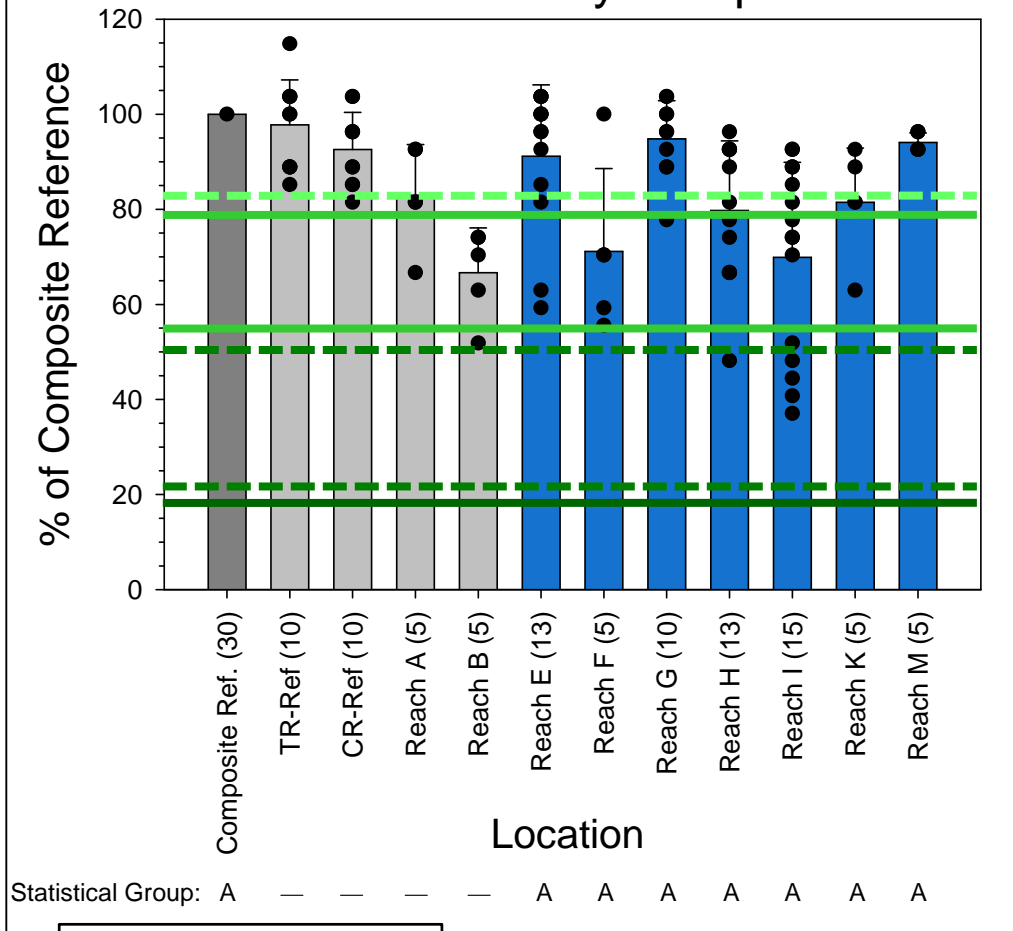


EPA Multi-Metric Scoring for Hester Dendy Compared to Composite Reference: Reaches

Benthic Community Assessment Report

Figure 4-4a

Biological Condition Score for Hester Dendy Samples



EPA Impairment Status Thresholds (a)

- Non (>83%)
- Slight (55-79%)
- Moderate (21-50%)
- Severe (<18%)

- TR Sample
- Reference Sample
- Composite Reference

Notes:

- This graphic reflects the same scoring data as Figure 4-4a, showing the EPA multi-metric scoring for each Reach for Hester-Dendy samples.
- Scoring ranges that reflect the impairment status designations are illustrated by the horizontal lines and defined as follows in comparison to the composite reference:
 - Non = non-impaired
 - Slight = slight impairment
 - Moderate = moderate impairment
 - Severe = severe impairment
- These grab sample results show that most Reaches are considered non-impaired. Two Reaches (F and I) are considered slightly impaired based on the percent similarity with the composite reference.
- Statistical testing shows that Reaches E-M are not statistically different than the composite reference.
- The scoring for reference Reach B shows some slight impairment.

Graphing:

- Bars/whiskers reflect the mean and one standard deviation for the replicates in each sample.
- Replicates as follows: Hester-Dendy = 5; grabs = 3, sweeps = 1.
- Circles reflect the individual replicate result. Note that some circles may overlap.
- Replicate counts are provided as numbers in parentheses along the x-axis labels.
- Statistical Group: A denotes location similar to the composite reference, - denotes statistical comparison not conducted.

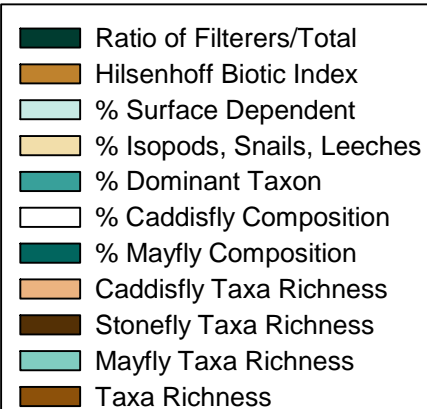
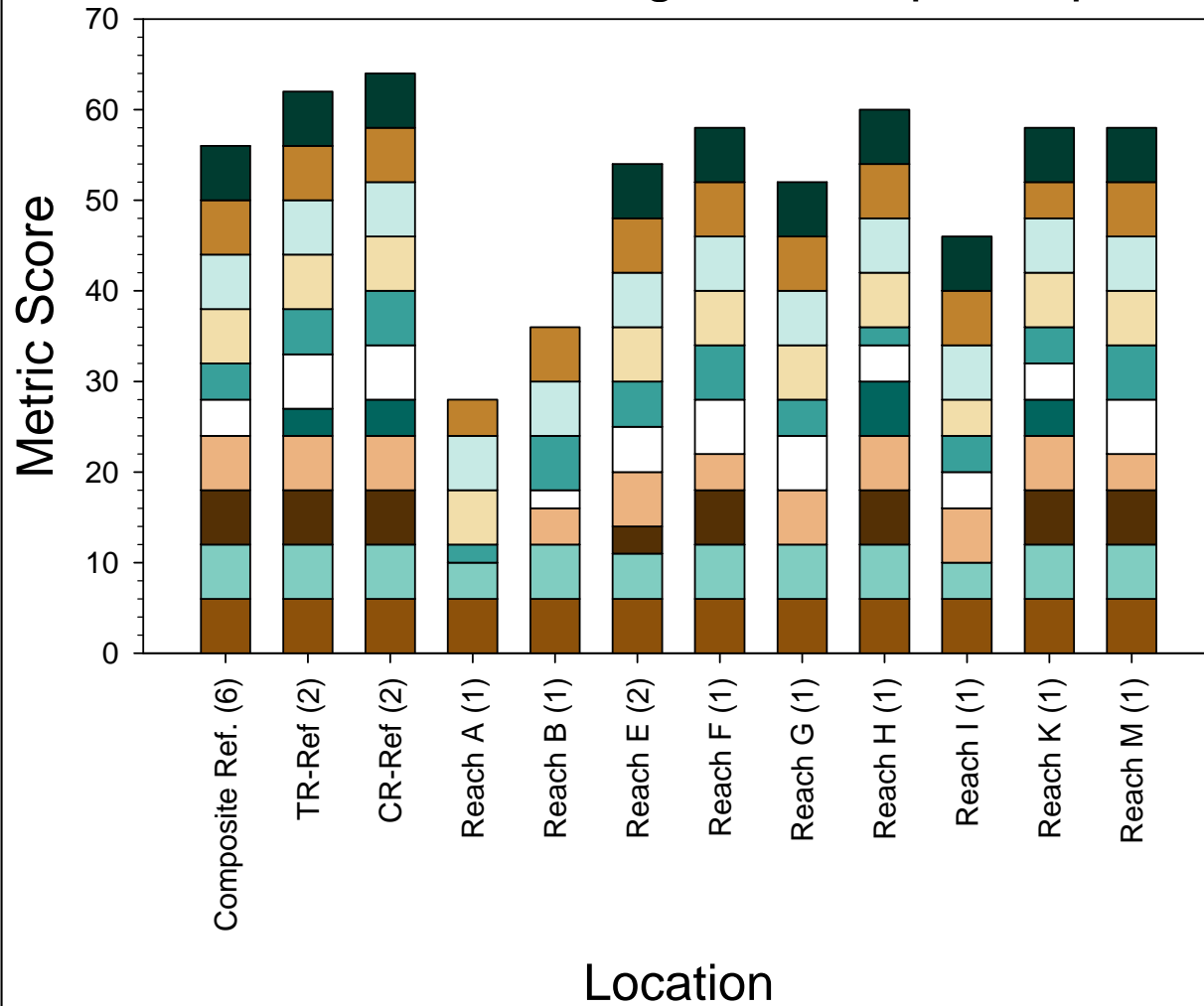
EPA Biological Condition Status for Hester Dendy Samples: Reaches

Benthic Community Assessment Report

Figure 4-4b



Multi-Metric Scoring for Sweep Samples



Notes:

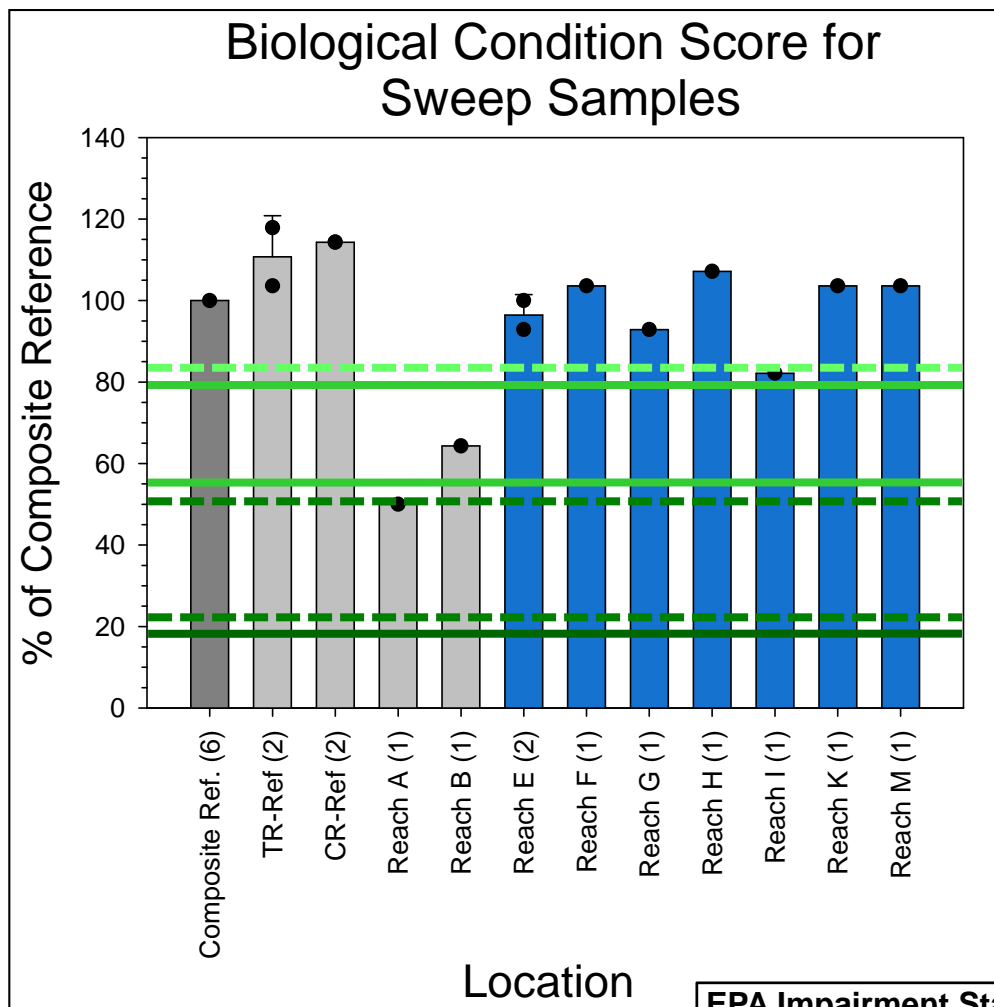
- This graphic presents the EPA multi-metric scoring for sweeps, with detailed insight into the specific metrics that are the basis of the composite reference and how each Reach compares to that composite reference.
- Statistical testing was not conducted for sweeps because the majority of samples are comprised of a single sample.



EPA Multi-Metric Scoring for Sweeps Compared to Composite Reference: Reaches

Benthic Community Assessment Report

Figure
4-5a

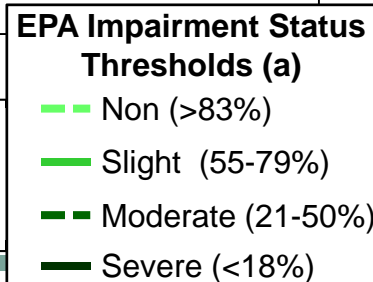
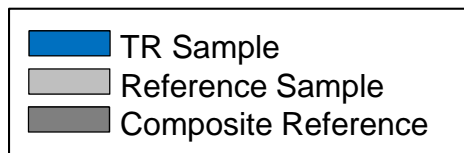


Notes:

- This graphic reflects the same scoring data as Figure 4-5a, showing the EPA multi-metric scoring for each Reach for Sweep samples.
- Scoring ranges that reflect the impairment status designations are illustrated by the horizontal lines and defined as follows in comparison to the composite reference:
 - Non = non-impaired
 - Slight = slight impairment
 - Moderate = moderate impairment
 - Severe = severe impairment
- These sweep sample results show that Reaches E- M are considered non-impaired.
- The scoring for reference Reaches A and B shows some impairment.

Graphing:

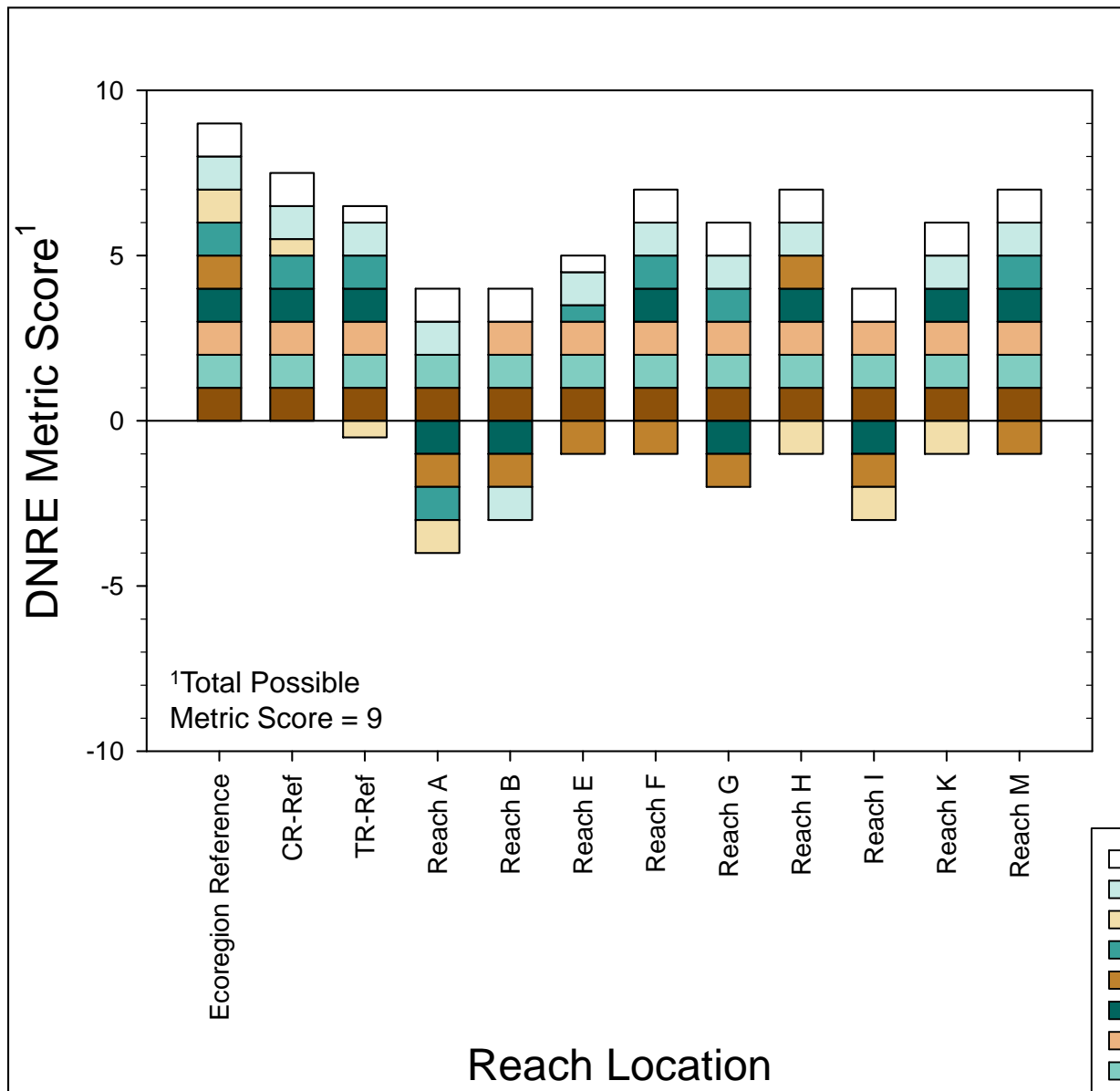
- Bars/whiskers reflect the mean and one standard deviation for the replicates in each sample.
- Replicates as follows: Hester-Dendy = 5; grabs = 3, sweeps = 1.
- Circles reflect the individual replicate result. Note that some circles may overlap.
- Replicate counts are provided as numbers in parentheses along the x-axis labels.



EPA Biological Condition Status for Sweep Samples: Reaches

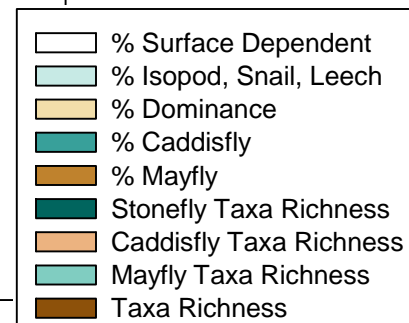
Benthic Community Assessment Report

Figure
4-5b



Notes:

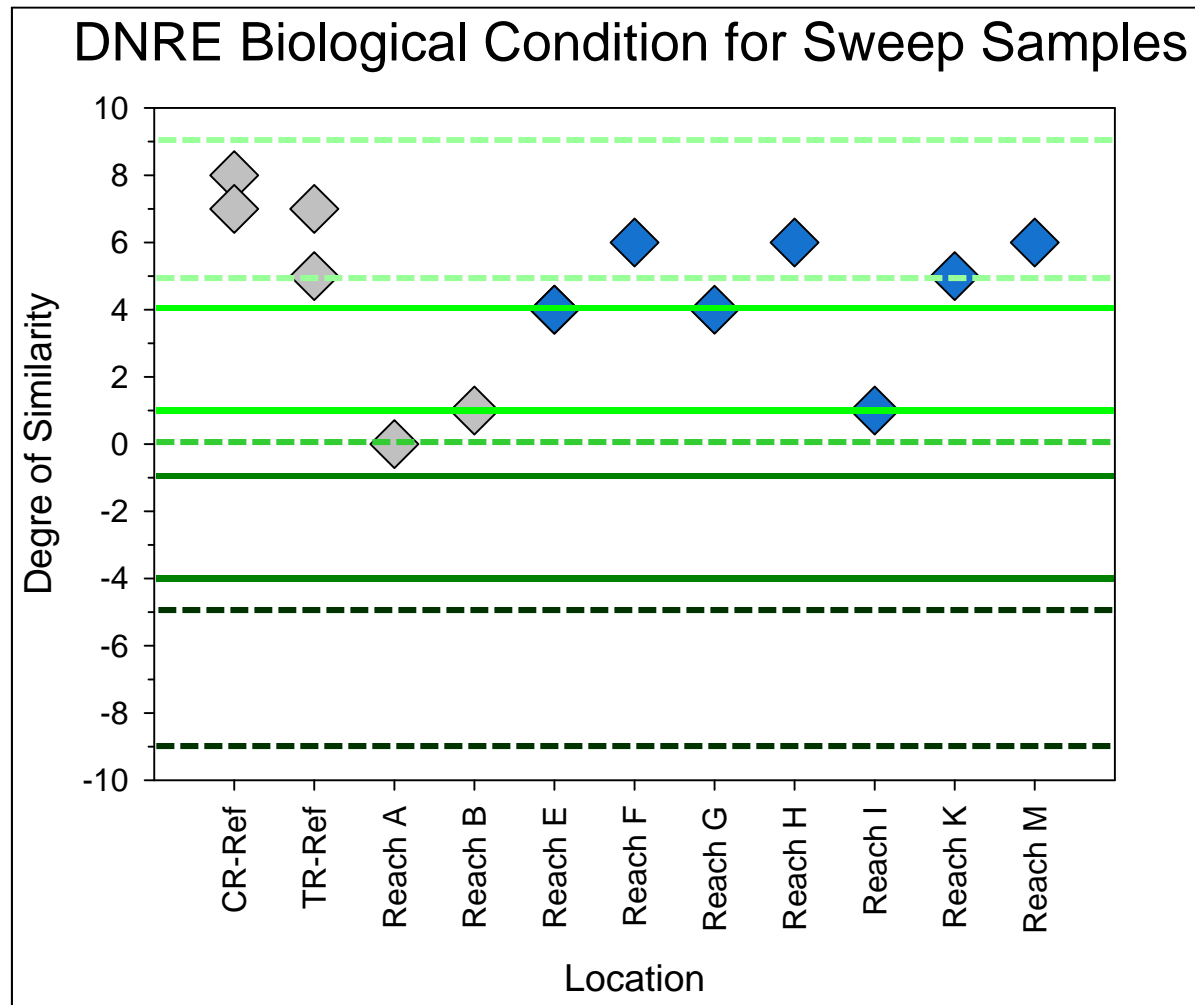
- This graphic presents the DNRE multi-metric scoring for sweeps, with detailed insight into the specific metrics that are the basis of the composite reference and how each Reach compares to that ecoregional reference.
- Statistical testing was not conducted for sweeps because the majority of samples are comprised of a single sample.



DNRE Multi-Metric Scoring for Sweeps Compared to Ecoregional Reference: Reaches

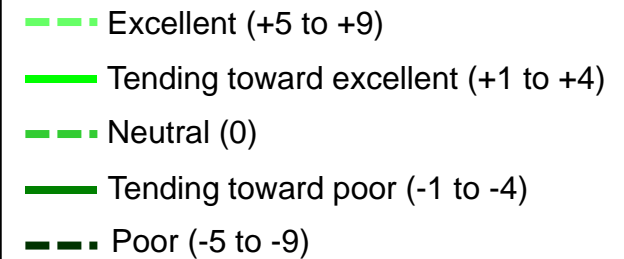
Benthic Community Assessment Report

Figure
4-6a



Notes:

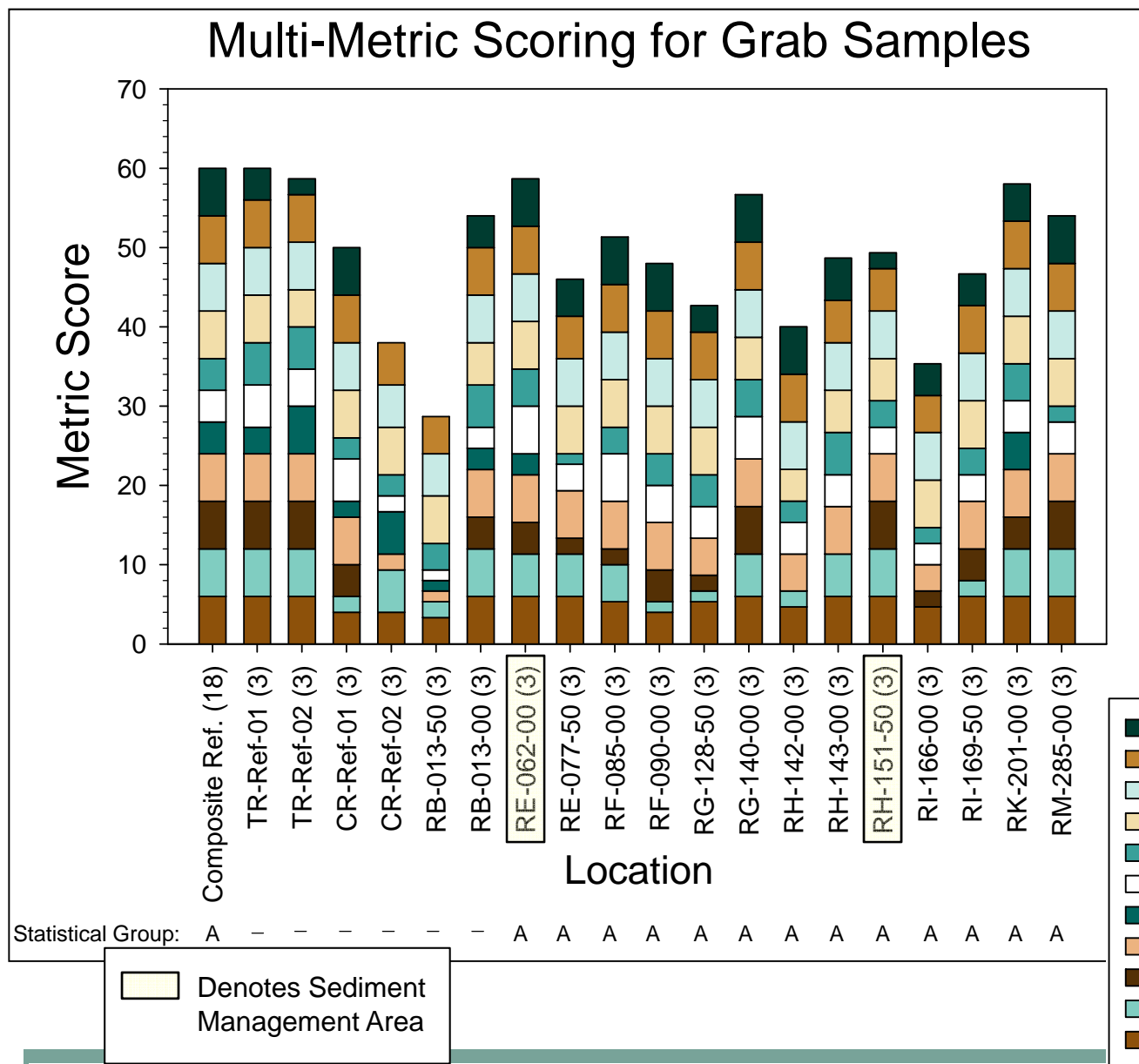
- This graphic reflects the same data as Figure 4-6a.
- Scoring ranges that reflect biological condition scoring relative to the Huron/Erie Lake Plains (HELP) Ecoregion (Omernik 1987):
 - Excellent
 - Tending toward excellent
 - Neutral
 - Tending toward poor
 - Poor
- These sweep scoring results show that the majority of locations fall within the excellent or tending toward excellent or excellent category, with exception for upstream locations in Reaches A and B and the Reach I locations.
- The lowest scoring for any location is designated as neutral (Reach A).



DNRE Biological Condition Status for Sweep Samples: Reaches

Benthic Community Assessment Report

Figure
4-6b



Notes:

- This graphic presents the EPA multi-metric scoring, with detailed insight into the specific metrics that are the basis of the composite reference and how each location compares to that composite reference.
- Statistical Group:
 - “A” denotes locations that are statistically similar to the composite reference.
 - -- denotes statistical comparison not conducted.
 - Results show that there are no statistically significant differences between the locations and the composite reference.

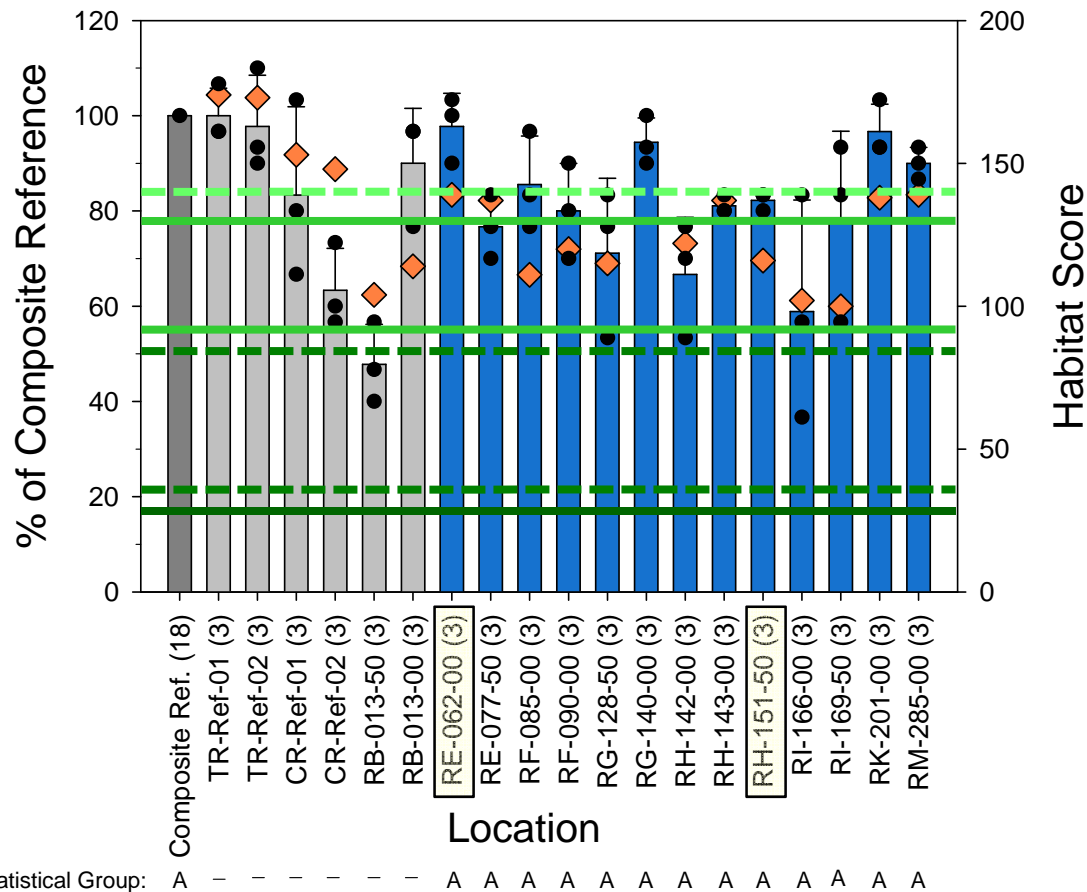


EPA Multi-Metric Scoring for Grabs Compared to Composite Reference: Location-Specific

Benthic Community Assessment Report

Figure
4-7a

Grab: Biological Condition vs Habitat

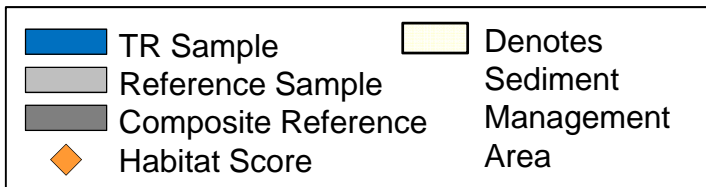


Notes:

- This graphic reflects the same scoring data as Figure 4-7a, showing the EPA multi-metric scoring for each location for Grab samples. This graphic also shows the habitat scoring for each location.
- Scoring ranges that reflect the impairment status designations are illustrated by the horizontal lines and defined as follows in comparison to the composite reference:
 - Non = non-impaired
 - Slight = slight impairment
 - Moderate = moderate impairment
 - Severe = severe impairment
- These grab sample results show that most locations are considered non-impaired or slightly impaired. Location RI-166+00 scored the lowest in comparison to the composite reference and in the habitat scoring.
- Statistical testing shows that locations in Reaches E-M are not statistically different than the composite reference.
- The scoring for two references (CR-Ref-02 and Reach RB-013+50) also show some impairment.

Graphing:

- Bars/whiskers reflect the mean and one standard deviation for the replicates in each sample.
- Replicates as follows: HD = 5; grabs = 3, sweeps = 1.
- Circles reflect the individual replicate result. Note that some circles may overlap.
- Replicate counts are provided as numbers in parentheses along the x-axis labels.
- Statistical Group: A denotes location similar to the composite reference, - denotes statistical comparison not conducted.



EPA Impairment Status Thresholds (a)

- Non (>83%)
- Slight (55-79%)
- Moderate (21-50%)
- Severe (<18%)

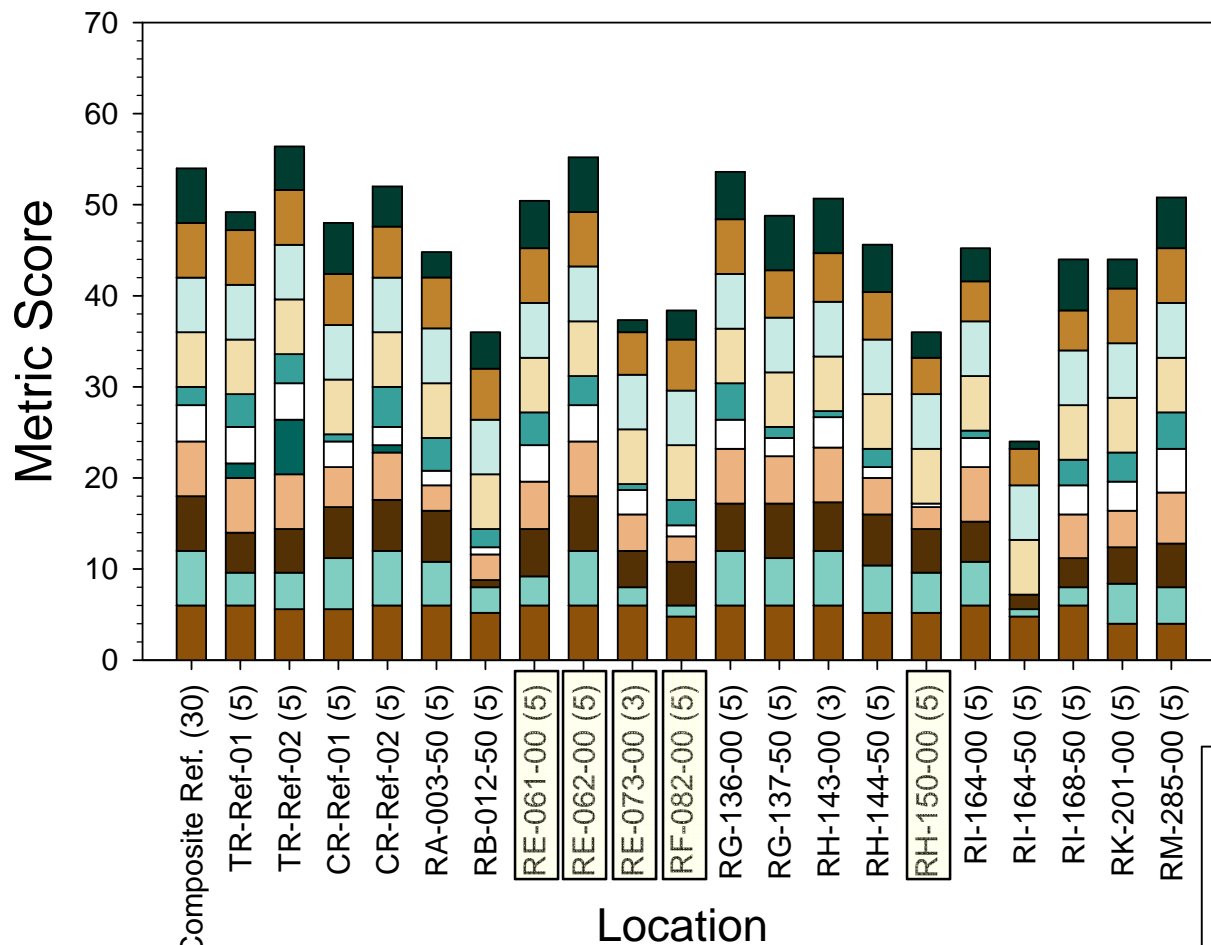


EPA Biological Condition and Habitat Score for Grab Samples: Location-Specific

Benthic Community Assessment Report

Figure 4-7b

Multi-Metric Scoring for Hester Dendy Samples



Notes:

- This graphic presents the EPA multi-metric scoring, with detailed insight into the specific metrics that are the basis of the composite reference and how each location compares to that composite reference.
- Statistical Group:
 - “A” denotes locations that are statistically similar to the composite reference.
 - -- denotes statistical comparison not conducted.
 - Results show that there are no statistically significant differences between the locations and the composite reference, with exception for Locations RI-164+50 and RH-150+00. The differences between RI-164+50 and the composite reference are statistically significant.

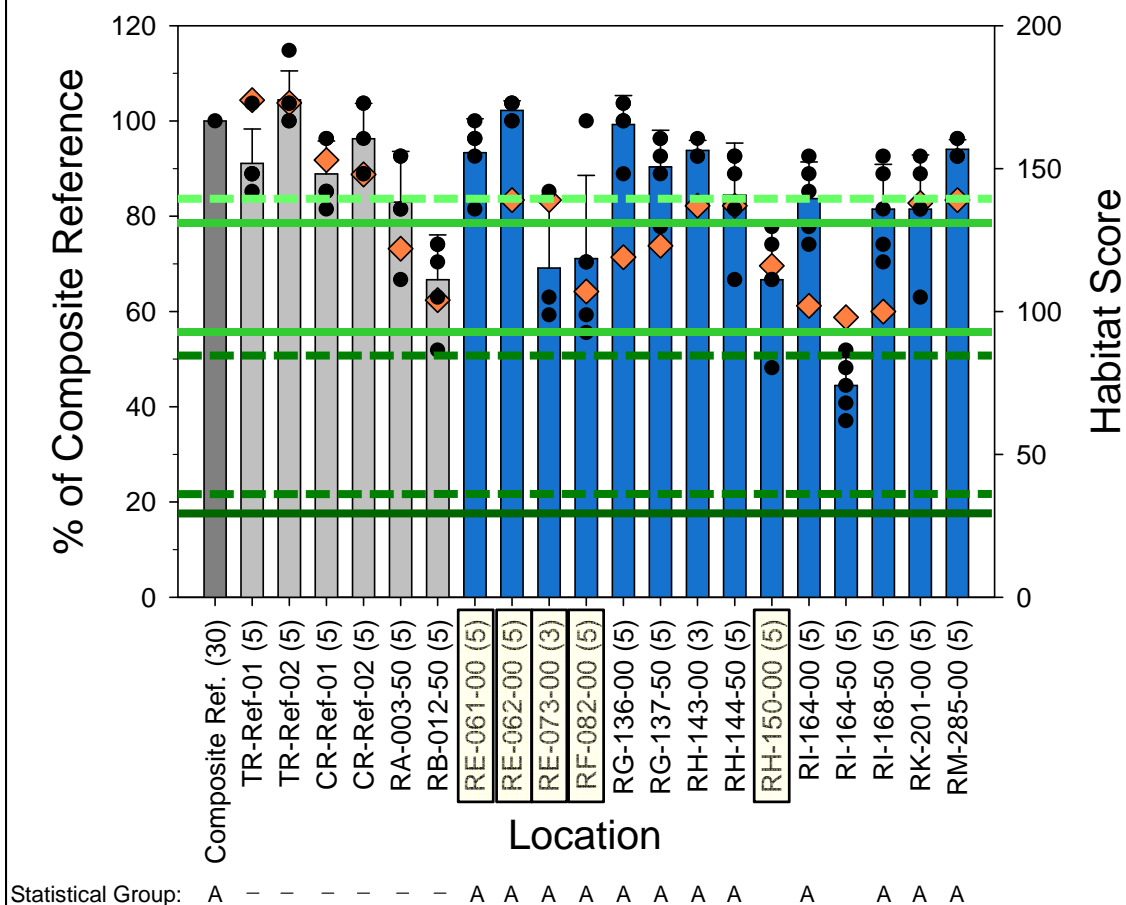


EPA Multi-Metric Scoring for Hester Dendy Compared to Composite Reference: Location-Specific

Benthic Community Assessment Report

Figure 4-8a

Hester Dendy: Biological Condition vs Habitat



■ TR Sample
■ Reference Sample
■ Composite Reference
◆ Habitat Score
 Denotes Sediment Management Area

EPA Impairment Status Thresholds (a)

--- Non (>83%)
--- Slight (55-79%)
--- Moderate (21-50%)
--- Severe (<18%)

Notes:

- This graphic reflects the same scoring data as Figure 4-8a, showing the EPA multi-metric scoring for each location for Hester-Dendy (HD) samples. This graphic also shows the habitat scoring for each location.
- Scoring ranges that reflect the impairment status designations are illustrated by the horizontal lines and defined as follows in comparison to the composite reference:
 - Non = non-impaired
 - Slight = slight impairment
 - Moderate = moderate impairment
 - Severe = severe impairment
- These HD sample results show that many locations are considered non-impaired and several are considered slightly impaired. Location RI-164+50 scored the lowest in comparison to the composite reference and was among the lowest in the habitat scoring.
- Statistical testing shows that locations in Reaches E-M are not statistically different than the composite reference, with the exception of RH-150+00 and RI-164+50, each of which show a statistically significant difference.

Graphing:

- Bars/whiskers reflect the mean and one standard deviation for the replicates in each sample.
- Replicates as follows: HD = 5; grabs = 3, sweeps = 1.
- Replicate counts are provided as numbers in parentheses along the x-axis labels.
- Statistical Group: A denotes location similar to the composite reference, - denotes statistical comparison not conducted.

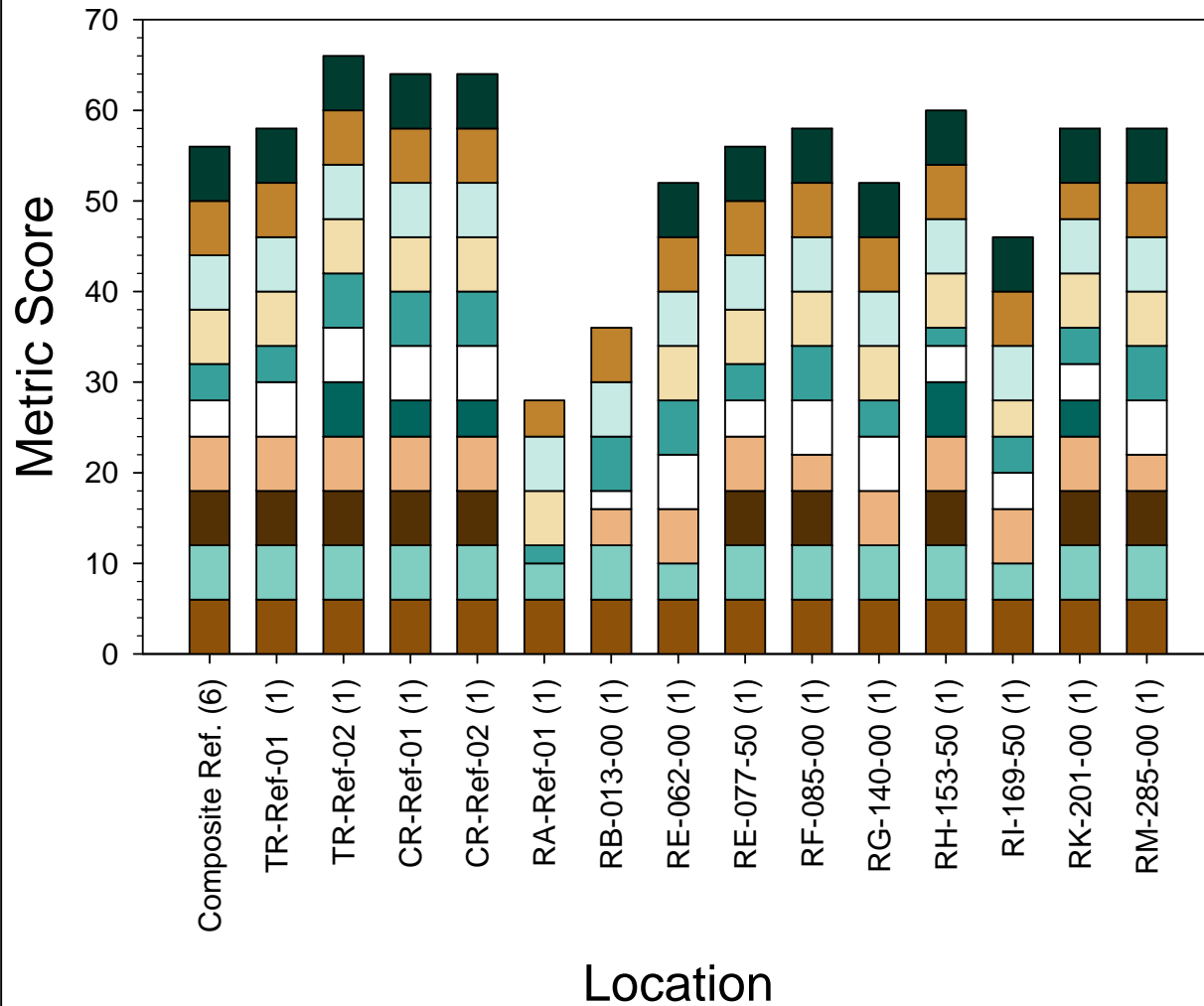


EPA Biological Condition and Habitat Score for Hester Dendy Samples: Location-Specific

Benthic Community Assessment Report

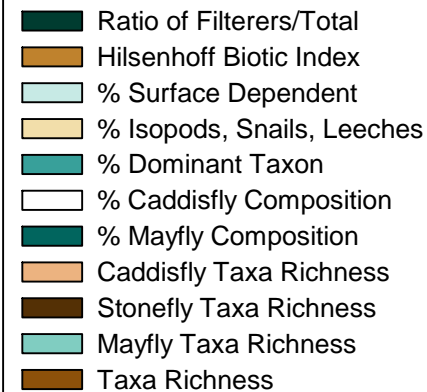
Figure 4-8b

Multi-Metric Scoring for Sweep Samples



Notes:

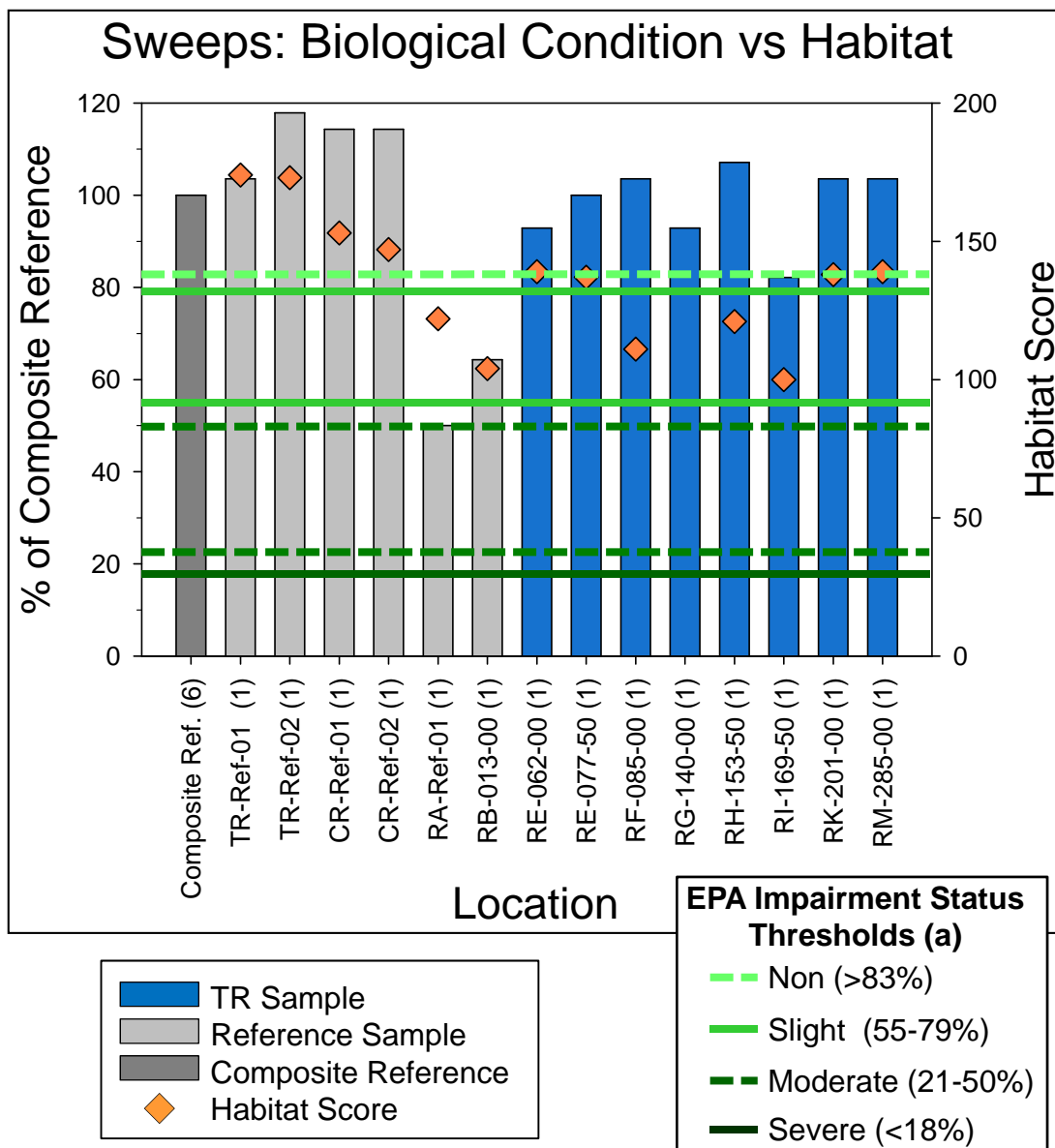
- This graphic presents the EPA multi-metric scoring, with detailed insight into the specific metrics that are the basis of the composite reference and how each sweep location compares to the composite reference.
- Statistical testing cannot be conducted for single samples.



EPA Multi-Metric Scoring for Sweeps Compared to Composite Reference: Location-Specific

Benthic Community Assessment Report

Figure
4-9a



Notes:

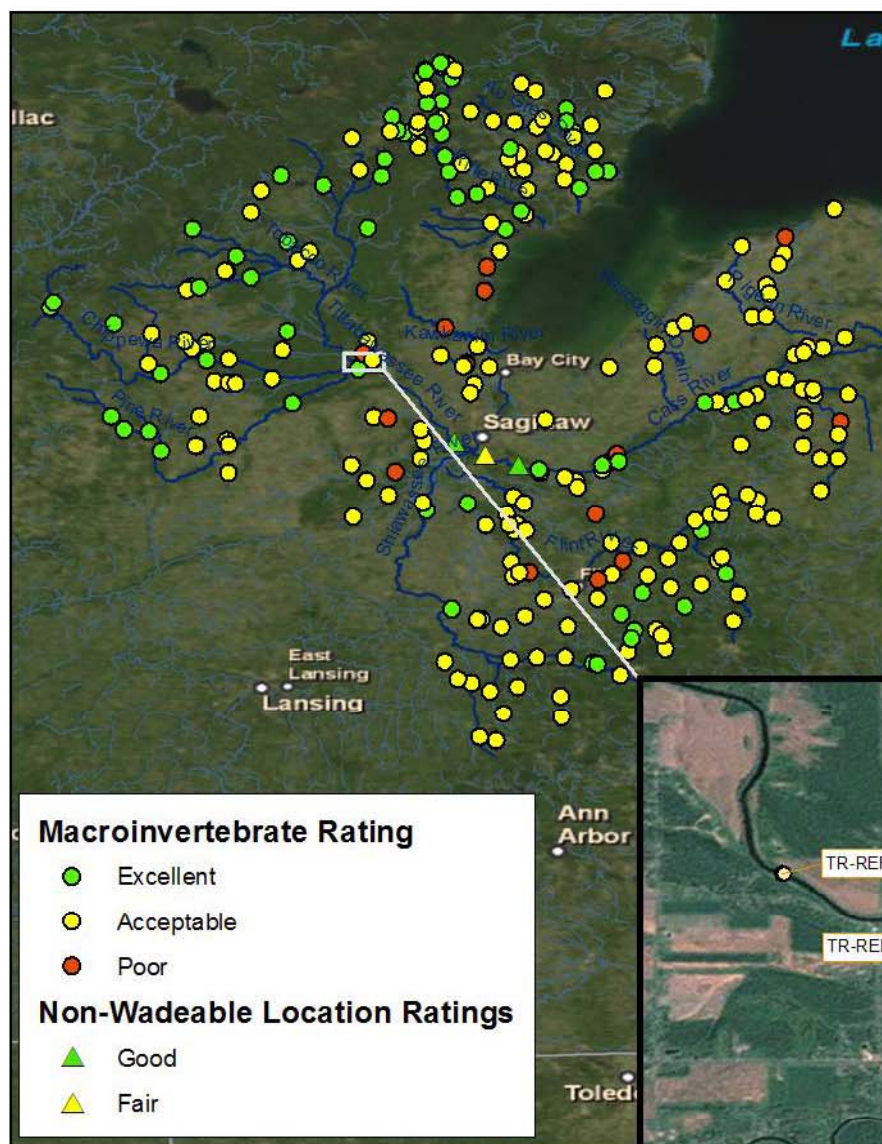
- This graphic reflects the same scoring data as Figure 4-9a, showing the EPA multi-metric scoring for each location for sweep samples. This graphic also shows the habitat scoring for each location.
- Scoring ranges that reflect the impairment status designations are illustrated by the horizontal lines and defined as follows in comparison to the composite reference:
 - Non = non-impaired
 - Slight = slight impairment
 - Moderate = moderate impairment
 - Severe = severe impairment
- These sweep sample results show that all locations within Reaches E through M are non-impaired.
- References in Reaches A and B show some impairment and also had among the lowest habitat scores.



EPA Biological Condition and Habitat Score for Sweep Samples: Location-Specific

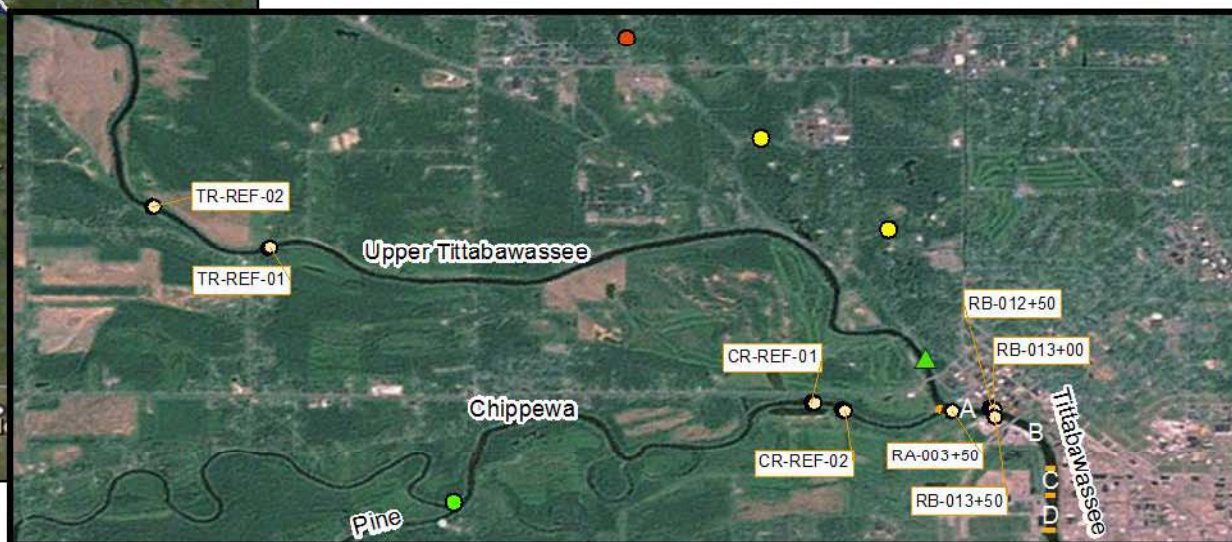
Benthic Community Assessment Report

Figure
4-9b



Notes:

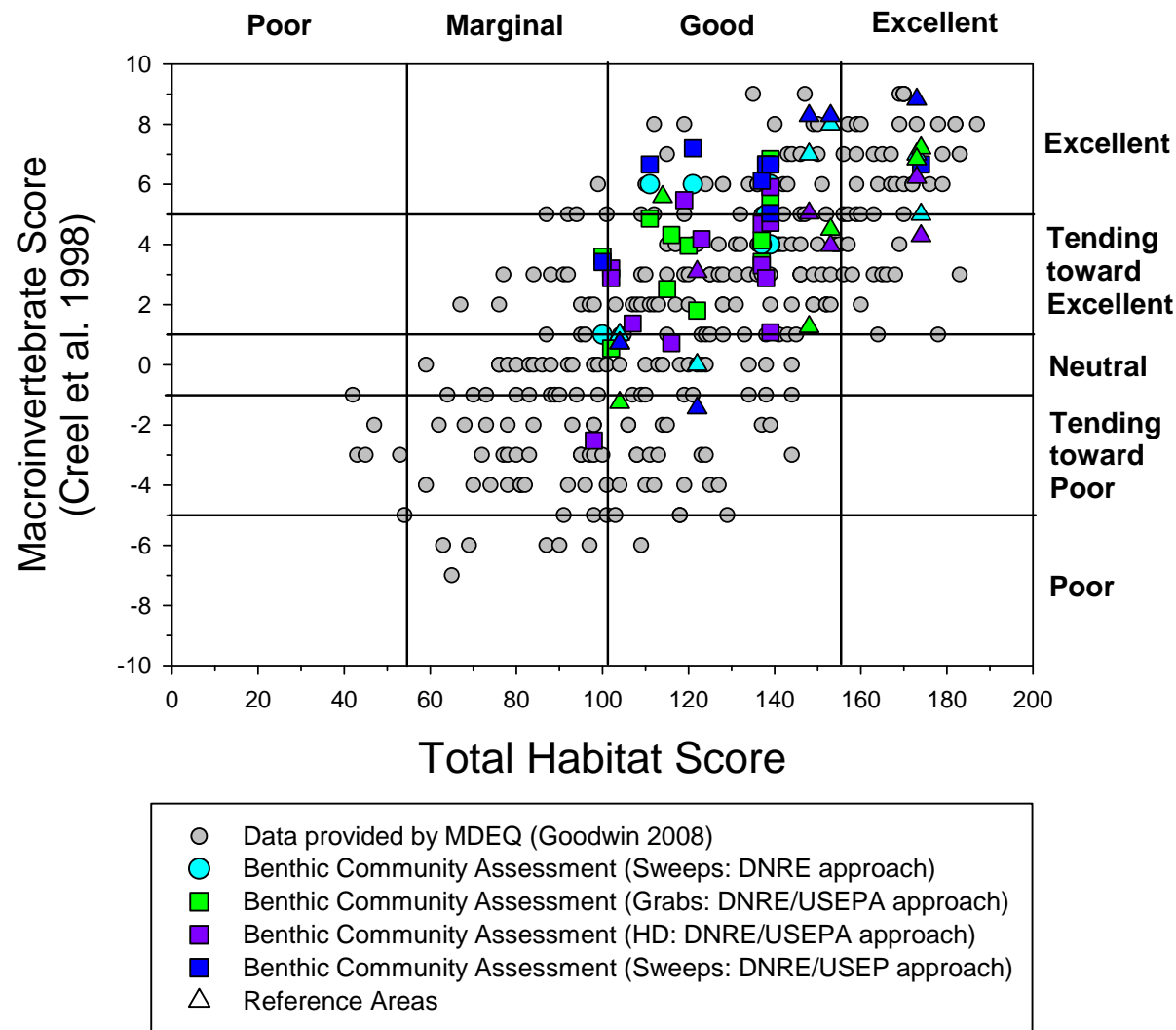
- MDNRE biological monitoring results are available for rivers in Michigan. There are some results for the Tittabawassee River, but not for Segments 1 and 2 or the reference locations included in the 2010 benthic community assessment.
- The available results for the Tittabawassee River are near the confluence with the Saginaw River and conditions were rated as acceptable and poor.



Macroinvertebrate Community Quality Ratings for Wadeable and Non-Wadeable Streams – Saginaw Bay Basin

Figure 5-1

Relationship between Habitat Quality and Benthic Community Quality



Notes:

- This graphic overlays the 2010 benthic community assessment results with the the DNRE macroinvertebrate scoring for other rivers in Michigan.
- The results are presented along a continuum of macroinvertebrate scoring and habitat scoring. Blue circles show the 2010 results, gray circles show the DNRE dataset. The 2010 results fall within the marginal to excellent habitat ranges and the neutral to excellent macroinvertebrate ranges.
- EPA scoring was normalized to the DNRE scoring so that these data could also be compared to other rivers in Michigan. Results for grabs, Hester-Dendy samples, and sweeps were also within ranges of marginal to excellent habitat and neutral to excellent benthic community scores.
- For each sample type, lower macroinvertebrate scores were generally related to lower habitat scores.



Relationship between Habitat Quality and Macroinvertebrate Community Quality in Wadeable Streams, Saginaw Bay Basin

Benthic Community Assessment Report

Figure
5-2

Tables

Table 2-1a. Summary of Benthic Community Assessment Samples Collected, Sample Locations, and Dates Sampled

Location	Date Collected	Grab Samples (3 replicates)	Sweep	TOC/Grain Size	Habitat Assessment Completed	Water Quality	Flow Measured
TR-Ref-01	9/30/2010	X	X	X	X	X	X
TR-Ref-02	9/29/2010	X	X	X	X	X	X
CR-Ref-01	9/29/2010	X	X	X	X	X	X
CR-Ref-02	9/29/2010	X	X	X	X	X	X
RA-Ref-01	9/29/2010	-	X	X	X	X	X
RA-Ref-02	9/29/2010	X	-	-	-	-	-
RB-013+00	10/1/2010	X	X	X	X	X	X
RE-062+00	9/30/2010	X	X	X	X	X	X
RE-077+50	9/30/2010	X	X	X	X	X	X
RF-085+00	9/30/2010	X	X	X	X	X	X
RF-090+00	9/30/2010	X	-	X	-	-	-
RG-128+50	9/30/2010	X	-	X	X	X	X
RG-140+00	10/1/2010	X	X	X	X	X	X
RH-142+00 ^a	9/28/2010	X	-	-	X	X	X
RH-143+00 ^a	9/28/2010	X	-	X	X	X	X
RH-151+50 ^b	10/1/2010	X	-	X	X	X	X
RH-153+50 ^b	10/1/2010	-	X	-	X	X	X
RI-166+00	10/1/2010	X	-	X	-	-	-
RI-169+50	10/1/2010	X	X	X	X	X	X
RK-201+00	10/1/2010	X	X	X	X	X	X
RM-285+00	10/1/2010	X	X	X	X	X	X

(a) Habitat assessment, water quality and flow measured were combined for these two samples

(b) Habitat assessment, water quality and flow measured were combined for these two samples

TOC: total organic carbon

Table 2-1b. Summary of Hester Dendy Deployment and Retrieval

Location	Deployment	Hester Dendys Placed/Retrieved					Retrieval
	Date	A	B	C	D	E	Date
TR-Ref-01	9/30/2010	X/X	X/X	X/X	X/X	X/X	10/27/2010
TR-Ref-02	9/29/2010	X/X	X/X	X/X	X/X	X/X	10/27/2010
CR-Ref-01	9/29/2010	X/X	X/X	X/X	X/X	X/X	10/27/2010
CR-Ref-02	9/29/2010	X/X	X/X	X/X	X/X	X/X	10/27/2010
RA-003+50	9/29/2010	X/X	X/X	X/X	X/X	X/X	10/27/2010
RB-012+50	9/29/2010	X/X	X/X	X/X	X/X	X/X	10/27/2010
RE-061+00	9/28/2010	X/X	X/X	X/X	X/X	X/X	10/29/2010
RE-062+00	9/28/2010	X/X	X/X	X/X	X/X	X/X	10/29/2010
RE-073+00	9/28/2010	X/X	X/X	X/-	X/-	X/X	10/28/2010
RF-082+00	9/30/2010	X/X	X/X	X/X	X/X	X/X	10/28/2010
RF-108+50	9/28/2010	X/-	X/-	X/-	X/-	X/-	-
RG-136+00	10/1/2010	X/X	X/X	X/X	X/X	X/X	10/29/2010
RG-137+50	9/28/2010	X/X	X/X	X/X	X/X	X/X	10/28/2010
RH-143+00	9/28/2010	X/X	X/X	X/X	X/-	X/-	10/28/2010
RH-144+50	9/28/2010	X/X	X/X	X/X	X/X	X/X	10/28/2010
RH-150+00	9/28/2010	X/X	X/X	X/X	X/X	X/X	10/27/2010
RI-164+00	9/28/2010	X/X	X/X	X/X	X/X	X/X	10/28/2010
RI-164+50	9/28/2010	X/X	X/X	X/X	X/X	X/X	10/27/2010
RI-168+50	9/28/2010	X/X	X/X	X/X	X/X	X/X	10/26/2010
RK-201+00	9/28/2010	X/X	X/X	X/X	X/X	X/X	10/26/2010
RM-285+00	9/28/2010	X/X	X/X	X/X	X/X	X/X	10/26/2010

Table 2-2a. Habitat Scoring Criteria For Wadeable Streams

Habitat Scoring Categories and Variables	Poor	Marginal	Good	Excellent
<i>Substrate and Instream Cover</i>				
Epifaunal Substrate/Available Cover	<20% of substrate is stable and free from sedimentation 0-5	20-40% of substrate is stable and free from sedimentation 6-10	40-70% of substrate is stable and free from sedimentation 11-15	>70% of substrate is stable and free from sedimentation 16-20
Embeddedness	>75% is gravel cobble, or boulder 0-5	50-75% is gravel, cobble, or boulder 6-10	25-50% is gravel, cobble, or boulder 11-15	0-25% is gravel, cobble, or boulder 16-20
Velocity/Depth Regime	Dominated by 1 regime 0-5	2 of 4 regimes present 6-10	3 of 4 regimes present 11-15	4 of 4 regimes present 16-20
<i>Channel Morphology</i>				
Sediment Deposition	>50% of bottom affected by sediment deposition 0-5	30-50% of bottom affected by sediment deposition 6-10	5-30% of bottom affected by sediment deposition 11-15	<5% of bottom affected by sediment deposition 16-20
Flow Status-Maintained Flow Volume	Little water in channel 0-5	Water in 25-75% of channel 6-10	Water in >75% of channel 11-15	Water reaches base of both lower banks 16-20
Channel Alteration	Recent channelization (<5 years) 0-5	Channelization is continuous but not recent (> 5 years) 6-10	Some past channelization evident (> 20 years) 11-15	Channelization and dredging absent 16-20
Frequency of Riffles/Bends	Distance between riffles/width of the stream= a ratio of >25 0-5	Distance between riffles/width of the stream= a ratio between 15 and 25 6-10	Distance between riffles/width of the stream= a ratio between 7 and 15 11-15	Distance between riffles/width of the stream= a ratio between 5 and 7 16-20
<i>Riparian and Bank Structure</i>				
Bank Stability	60-100% of bank has erosion 0-5	30-60% of bank has erosion 6-10	5-30% of bank has erosion 11-15	<5% of bank has erosion 16-20
Vegetative Protection	<50% of bank covered by vegetation 0-5	50-70% of bank covered by vegetation 6-10	70-90% of bank covered by vegetation 11-15	>90% of bank covered with vegetation 16-20
Riparian Vegetation Zone Width	Zone Width: <10 feet 0-5	Zone Width: 10-75 feet 6-10	Zone Width: 75-150 feet 11-15	Zone Width: >150 feet 16-20
Total Score	0-50	51-100	101-150	151-200

Source: DEQ 2008

Table 2-2b. Habitat Assessment Scores for Benthic Community Locations

Reach ID	Sample Type	Riffle/Run	Substrate and Instream Cover			Channel Morphology				Riparian and Bank Structure			Total Score (out of 200)	Ranking
			Epifaunal Substrate/ Available Cover	Embeddedness/ Pool Substrate Characterization	Velocity/ Depth Regime	Sediment Deposition	Flow Status	Channel Alteration	Frequency of Riffles/ Bends	Bank Stability	Vegetative Protection	Riparian Vegetation Zone Width		
TR-Ref-01	G/HD/S	Riffle/Run	20	20	20	16	16	15	18	13	18	18	174	Excellent
TR-Ref-02	G/HD/S	Riffle/Run	20	20	20	16	16	15	16	16	18	16	173	Excellent
CR-Ref-01	G/HD/S	Riffle/Run	11	18	20	13	16	13	13	15	18	16	153	Good
CR-Ref-02	G/HD/S	Riffle/Run	11	15	20	13	16	13	13	15	14	18	148	Good
RA-003+50 (a)	HD/S	Run	13	11	16	16	16	8	6	14	14	8	122	Good
RB-013+00 (b)	G	Run	13	11	16	10	16	8	6	14	14	6	114	Good
RB-013+50 (c)	G/HD/S	Run	10	11	16	10	11	6	6	16	12	6	104	Marginal
RE-062+00	G/HD/S	Riffle/Run	18	16	18	16	15	10	18	14	12	2	139	Good
RE-073+00	HD	Riffle/Run	18	16	18	16	15	10	18	14	12	2	139	Good
RE-77+50	G/S	Riffle/Run	16	16	18	16	15	10	18	14	12	2	137	Good
RF-082+00	HD	Riffle/Run	13	15	16	10	15	6	10	14	6	2	107	Good
RF-085+00	G/S	Riffle/Run	16	15	16	11	15	6	10	14	6	2	111	Good
RF-090+00	G	Riffle/Run	18	18	16	15	15	6	10	14	6	2	120	Good
RG-128+50	G	Riffle/Run	16	11	16	10	15	6	10	14	11	6	115	Good
RG-136+00	HD	Riffle/Run	13	10	16	10	15	10	10	13	11	11	119	Good
RG-140 +00	HD	Run	16	13	16	10	15	10	10	11	11	11	123	Good
RH-142+00	G	Riffle/Run	13	13	16	8	15	8	13	14	11	11	122	Good
RH-143+00	G/HD/S	Riffle/Run	18	18	16	10	18	8	13	14	11	11	137	Good
RH-144+50	HD	Riffle/Run	18	18	16	10	18	8	13	14	11	11	137	Good
RH-150+50	HD	Riffle/Run	13	11	16	10	15	6	10	14	10	11	116	Good
RH-151+50	G	Run	13	11	16	10	15	6	10	14	10	11	116	Good
RH-153+50	S	Run	16	13	16	10	15	6	10	14	10	11	121	Good
RI-164+00	HD	Run	11	11	16	6	18	3	6	11	10	10	102	Marginal
RI-164+50	HD	Run	11	10	15	6	16	3	6	11	10	10	98	Marginal
RI-166+00	G/HD	Riffle/Run	11	11	16	6	11	6	10	11	10	10	102	Marginal
RI-169+50	G/HD/S	Riffle/Run	11	11	16	6	11	6	10	11	8	10	100	Marginal
RK-201+00	G/HD/S	Riffle/Run	18	15	16	11	11	10	13	11	18	15	138	Good
RM-285+00	G/HD/S	Riffle/Run	18	13	16	11	11	10	13	9	18	20	139	Good

(a) Referred to as RA-Ref-01 in some field notes.

(b) Referred to as RA-Ref-02 in some field notes.

(c) Referred to as RB-Ref-01 in some field notes.

G: Grab

HD: Hester-Dendy

S: Sweep

Excellent Score >154
 Good Score 105-154
 Marginal Score 56-104
 Poor Score <56

Table 2-3. Sediment Substrate for Benthic Community Locations (Observational Survey)

Reach ID	Date	Bedrock	Boulder (>256 mm)	Cobble	Gravel	Sand	Silt	Clay
TR-Ref-01-IC	9/30/2010	0	20	40	20	20	0	0
TR-Ref-02	9/29/2010	0	20	30	20	30	0	0
CR-Ref-01	9/29/2010	0	0	0	50	45	5	0
CR-Ref-02	9/29/2010	0	0	0	2	98	0	0
RA-Ref-01	9/29/2010	0	30	60	10	0	0	0
RB-013+00	10/1/2010	0	40	0	0	30	30	0
RE-062+00	9/30/2010	0	5	5	50	40	0	0
RE-077+50	9/30/2010	0	10	20	10	0	60	0
RF-085+00	9/30/2010	0	25	30	25	20	0	0
RG-128+50	9/30/2010	0	10	30	25	45	0	0
RG-140-IC	9/30/2010	0	0	10	40	50	0	0
Rock Island	10/1/2010	0	30	25	20	25	0	0
RH-153+50, RH-151+50, RH-143+50	10/1/2010	0	0	0	30	35	35	0
RI-169+50	10/1/2010	0	0	0	30	35	35	0
RK-201+00	10/1/2010	0	50	20	0	10	10	0
RM-285+00	10/1/2010	0	30	20	10	20	20	0

mm: millimeter(s)

reference area location

Table 2-4a Summary of Grain Size Distribution

		Seive Size/ Percent Passing														
Sample ID	Date Sampled	3"	2"	1.5"	1"	0.75"	0.5"	0.375"	0.187"	0.0937"	0.0469"	0.0234"	0.0117"	0.0059"	0.0029"	Pan
CR-Ref-01-IC-SD	9/29/2010	100	100	100	100	100	98	95	91	85	78	65	23	3	2	2
CR-Ref-02-IC-SD	9/29/2010	100	100	100	100	100	100	100	100	97	91	72	14	1	1	1
TR-Ref-01-IC-SD	9/29/2010	100	100	100	100	84	72	56	42	29	19	13	8	3	2	2
TR-Ref-02-IC-SD	9/29/10	100	100	100	100	93	86	80	65	57	53	52	45	20	13	13
RA-Ref-01-IC-SD	9/29/10	100	100	100	100	100	94	91	88	85	83	81	73	13	3	2
RB-13+00-IC-SD	10/1/10	100	100	100	100	100	98	97	96	95	94	94	89	17	3	2
RE-62+00-IC-SD	9/30/10	100	100	100	82	62	48	39	24	18	14	10	2	1	1	1
RE-77+50-IC-SD	9/30/10	100	100	100	100	100	100	100	99	97	96	94	90	86	85	85
RF-85+00-IC-SD	9/30/10	100	100	100	100	100	76	65	50	38	25	15	3	1	1	1
RF-90+00-IC-SD	9/30/10	100	100	100	100	100	90	88	85	84	77	50	4	1	1	1
RG-128+50-IC-SD	9/30/10	100	100	100	100	78	66	61	51	48	47	45	11	1	1	1
RG-140+00-IC-SD	9/30/10	100	100	100	100	100	100	97	84	69	55	44	11	1	1	0
RH-143+00-IC-SD	10/4/10	100	100	100	92	76	56	48	42	38	36	35	27	3	1	1
RH-151+50-IC-SD	10/1/10	100	100	100	100	100	96	93	85	73	65	59	35	10	2	2
RI-166+00-IC-SD	10/1/10	100	100	100	100	100	95	92	83	80	79	77	63	18	3	3
RI-169+50-IC-SD	10/1/10	100	100	100	100	96	90	83	61	47	39	34	18	5	2	2
RK-201+00-IC-SD	10/1/10	100	100	100	100	100	65	50	31	22	19	18	11	2	1	1
RM-285+00-IC-SD	10/1/10	100	100	100	78	57	40	38	32	27	26	25	16	3	1	1

Reference area locations
 Sample particle size is less than seive size.
 Size range that comprises 50 to 99.5% of sample.
 inches

**Table 2-4b. Summary of Total Organic Carbon Concentrations
and Moisture Content**

Location	Collection Date	TOC (% ww)	Moisture Content (%)
TR-Ref-01	9/30/2010	1	13.6
TR-Ref-02	9/29/2010	1.2	15.2
CR-Ref-01	9/29/2010	0.46	26.9
CR-Ref-02	9/29/2010	0.12	20.5
RA-Ref-01	9/29/2010	0.25	22.3
RB-13+00	10/1/2010	<0.12	22
RE-62+00	9/30/2010	1.1	14.1
RE-77+50	9/30/2010	2.1	26.2
RF-85+00	9/30/2010	0.98	15.7
RF-90+00	9/30/2010	0.44	19.6
RG-128+50	9/30/2010	1.2	19.1
RG-140+00	9/30/2010	2.3	16.8
RH-143+00	10/4/2010	0.99	18.9
RH-151+50	10/1/2010	1.6	15.7
RI-166+00	10/1/2010	0.59	21
RI-169+50	10/1/2010	2.5	26.3
RK-201+00	10/1/2010	1.2	12.7
RM-285+00	10/1/2010	0.83	18.8

%: percent
 TOC: total organic carbon
 ww: wet weight

Table 2-5. Water Quality Measurements for Benthic Community Locations

Reach ID	Date	Flow (ft/s)	Salinity (pss)	ORP (mV)	Temp (C)	DO (mg/L)	Spec Conduct (mS)	pH	Turbidity (NTU)
TR-Ref-01	9/30/2010	0.31	0.26	61	15.36	8.52	0.54	8.68	1.3
TR-Ref-02	9/29/2010	1.53	0.25	34	14.48	9.52	0.52	9.09	0.2
CR-Ref-01	9/29/2010	0.96	0.25	8	14.97	12.71	0.52	9.29	1.8
CR-Ref-02	9/29/2010	0.79	0.25	35	15.04	12.44	0.53	9.65	1.5
RA-Ref-01	9/29/2010	0.82	0.24	17	15.62	12.06	0.51	9.18	7.1
RB-013+00	10/1/2010	0.25	0.24	-8	15.93	9.32	0.51	9.16	1.7
RE-062+00	9/30/2010	1.3	0.24	25	16.53	9.80	0.49	9.10	0.6
RE-077+50	9/30/2010	0.13	0.23	46	16.76	9.96	0.48	9.09	2.7
RF-085+00	9/30/2010	1.42	0.23	34	16.36	10.62	0.49	9.02	2.1
RG-128+50	9/30/2010	1.17	0.23	4	17.04	10.56	0.48	9.28	1.1
RG-140	9/30/2010	1.48	0.24	20	16.72	20.85	0.50	9.27	0.3
RH-153+50, RH-151+50, RH-143+50	10/1/2010	0.41	0.24	63	15.46	12.10	0.50	9.25	0.2
RI-169+50	10/1/2010	0.86	0.31	-33	15.84	12.68	0.65	9.63	2.8
RK-201+00	10/1/2010	0.52	0.33	-19	16.20	10.76	0.68	9.14	1.6
RM-285+00	10/1/2010	0.27	0.34	-54	16.41	10.95	0.70	9.55	3.2

C: Celsius
 DO: dissolved oxygen
 ft/s: feet per second
 mg/L: milligram(s) per liter
 mS: millisiemen
 mV: millivolts
 NTU: Nephelometric turbidity unit
 ORP: oxidation reduction potential
 pss: practical salinity scale

Table 2-6. Sweep Habitat Characteristic Composition

Reach ID	Date	Six Habitat Subsamples Comprise Each Sweep Sample					
		1	2	3	4	5	6
TR-Ref-01	9/30/2010	boulder w/ vegetation	boulder with algae	vegetation	vegetation/leaf pack	woody debris	gravel area
TR-Ref-02	9/29/2010	boulder	vegetation/leaf pack	silty bottom	gravel bottom	cobble bottom	plants
CR-Ref-01	9/29/2010	cobble	boulder	vegetation	woody debris	leaf pack	algae/sandy bottom
CR-Ref-02	9/29/2010	woody debris	woody debris	submerged aquatic vegetation	submerged aquatic vegetation	leaf pack	vegetation margin
RA-Ref-01	9/29/2010	cobble	leaf pack	submerged vegetation	woody debris	cobble with algae	soft sediment/gravel
RB-013+00	10/1/2010	cobble with algae	boulder with aglae	leaf pack	leaf pack	soft sediment/gravel	vegetation
RE-062+00	9/30/2010	woody debris	cobble/gravel	cobble/gravel	vegetation/gravel	vegetation/gravel	vegetation
RE-077+50	9/30/2010	cobble/gravel/moss	gravel/vegetation	boulder/moss/algae	cobble/gravel/silt	cobble/gravel/silt	cobble/gravel/ vegetation
RF-085+00	9/30/2010	sand	sand/vegetation	sand/silt	sand/silt	sand	cobble/gravel
RG-128+50	9/30/2010						
RG-140-IC	9/30/2010	wood	wood/leaf pack	wood/leaf pack	wood/leaf pack	sand	wood/leaf pack
Rock Island	10/1/2010						
RH-153+50, RH-151+50, RH-143+50	10/1/2010	woody debris/gravel	woody debris/leaf pack	woody debris	algae covered boulder	algae/cobble	veg pack/soft sediment
RI-169+50	10/1/2010	vegetation	leaf pack	leaf pack	cobble/gravel	boulder with algae	large woody debris
RK-201+00	10/1/2010	cobble	cobble	vegetation	leaf pack	leaf pack	boulder with algae
RM-285+00	10/1/2010	boulder with aglae	leaf pack	vegetation	vegetation	cobble	cobble

Table 3-1. Metric Calculations for Benthic Community Assessment: EPA and DNRE

Benthic Macroinvertebrate Metric	Metric Measure_b	Formula
1. Total Taxa ^{a,b}	Richness	Number of species
2. Mayfly Taxa ^a	Richness	Number of taxa in the order Ephemeroptera (mayfly)
3. Caddisfly Taxa ^a	Richness	Number of taxa in the order Trichoptera (caddisfly)
4. Stonefly Taxa ^a	Richness	Number of taxa in the order Plecoptera (stonefly)
5. % Mayfly ^a	Composition	Number of individuals in the order Ephemeroptera ÷ total number of individuals in sample
6. % Caddisfly ^a	Composition	Number of individuals in the order Trichoptera ÷ total number of individuals in sample
7. % Isopod, Snail, Leech ^a	Composition	Number of individuals in the order Isopoda, class Gastropoda, and class Hirudinea ÷ total number of individuals in sample
8. % Dominance ^{a,b}	Tolerance	Number of individuals in most dominant taxon ÷ total number of individuals
9. % Surface Dependent ^{a,c}	Tolerance	Number of surface dependent individuals ÷ the total number of individuals in sample
10. Hilsenhoff Biotic Index (modified) ^b	Tolerance	$\sum (X_i \times t_i) \div n$
11. Ratio of Filterers/Total ^b	Functional Feeding Group	Number of individuals in the filterer functional feeding group ÷ total number of individuals in sample

(a) Based on DNRE 2008

(b) Based on USEPA 1989, 1999

(c) Based on list provided in Appendix I of DEQ 2008

DEQ: Department of Environmental Quality

DNRE: Michigan Department of Natural Resources and Environment

n: total number of organisms in the sample

t_i: tolerance value of a species

EPA: United States Environmental Protection Agency

X_i: number of individuals within a species

Table 3-2. EPA Benthic Macroinvertebrate Scoring Criteria

Benthic Macroinvertebrate Metric	Biological Condition Scoring Criteria*			
	6	4	2	0
1. Taxa Richness ^{a,b}	> 80 %	60-80 %	40-59 %	< 40 %
2. Mayfly Taxa ^{a,b}	> 80 %	60-80 %	40-59 %	< 40 %
3. Caddisfly Taxa ^{a,b}	> 80 %	60-80 %	40-59 %	< 40 %
4. Stonefly Taxa ^{a,b}	> 80 %	60-80 %	40-59 %	< 40 %
5. % Mayfly ^{c,d}	> 23 %	23-15 %	5-14 %	< 5 %
6. % Caddisfly ^{c,d}	> 22 %	22-3 %	1-2 %	< 1 %
7. % Isopod, Snail, Leeches ^{c,d}	< 6 %	6-13 %	14-15 %	> 15 %
8. % Dominance ^{b,c}	< 20 %	20-30 %	30-40 %	> 40 %
9. % Surface Dependent ^{c,d}	< 10 %	10-23 %	24-30 %	>30 %
10. Hilsenhoff Biotic Index (modified) ^{b,e}	> 85 %	70-85 %	50-70 %	< 50 %
11. % Filterers ^{a,b,f}	> 80 %	60-80 %	40-60 %	< 40 %

Comparison to Reference Score (g)	Biological Condition Category (g)	Support Status (g)
> 83 %	Nonimpaired	Comparable to a reference station (upstream location).
54-79 %	Slightly impaired	Community structure less than expected compared to the reference station. Composition (species richness) lower than expected due to loss of some intolerant forms. Percent contribution of tolerant forms increases.
21-50 %	Moderately impaired	Fewer species due to loss of most intolerant forms.
< 17 %	Severely impaired	Few species present. If high densities of organisms, then dominated by one or two taxa.

* Biological condition scoring criteria is based on USEPA (1989) and Creel et al. (1998) guidance documents.

(a): Score is a ratio of study site to reference site x 100.

(b): Biological condition scoring criteria values are based on USEPA 1989.

(c): Scoring criteria evaluate actual percent contribution, not percent comparability to the reference station.

(d): Biological condition scoring criteria values are based on Creel et al. 1998.

(e): Score is a ratio of reference site to study site x 100.

(f): Determination of Functional Feeding Group is independent of taxonomic grouping.

(g): Percentage values obtained that are intermediate to the above ranges will require subjective judgement as to the correct placement. Use of habitat assessment and physiochemical data may be necessary to aid in the decision process (USEPA 1989).

DNRE: Michigan Department of Natural Resources and Environment

EPA: United States Environmental Protection Agency

Table 3-3: DNRE Procedure 51 Macroinvertebrate Metric Scoring and Interpretation: Ecoregion HELP

Benthic Macroinvertebrate Metric	Stream Width	1	0	-1
1. Total Taxa	≥14	>31	18–31	<18
2. Mayfly Taxa	≥27	>3	2–3	<2
3. Caddisfly Taxa	≥14	>3	2–3	<2
4. Stonefly Taxa	All	>0	–	0
5. % Mayfly	All	>23	23–15	<15
6. % Caddisfly	All	>22	22–3	<3
7. % Isopods, Snail, Leech	All	<6	6–13	>13
8. % Dominance	All	<16	16–22	>22
9. % Surface Dependent	All	<10	10–23	>23

Metric Score	Biosurvey Category
+5 to +9	excellent
+1 to +4	tending toward excellent
0	neutral
-1 to -4	tending toward poor
-5 to -9	poor

DNRE: Michigan Department of Natural Resources and Environment
 HELP: Huron/Erie Lake Plain

Table 4-1a. Summary of Metric Results for Grab Samples

Location	Taxa Richness	# of Mayfly Taxa	# of Stonefly Taxa	# of Caddisfly Taxa	% Mayfly Comp	% Caddisfly Comp	% Dominant Taxon	% Isopods, Snails, Leeches	% Surface Dependent	HBI	Ratio of Filterers/Total
RE-062-00-IC-SBA	46	7	1	10	13.4	31.1	11.6	1.9	0.26	4.9	0.51
RE-062-00-IC-SBB	33	4	0	8	22.9	42.7	26.4	4.2	0.10	4.6	0.52
RE-062-00-IC-SBC	36	5	1	9	16.2	35.4	27.0	1.9	0	4.2	0.69
RE-077-50-IC-SBA	29	6	0	6	13.9	11.9	45.3	2.8	0	5.5	0.27
RE-077-50-IC-SBB	25	4	1	5	4.8	9.9	44.3	3.6	0	5.9	0.27
RE-077-50-IC-SBC	37	6	0	6	5.6	2.2	26.9	1.1	0	6.4	0.13
RF-085-00-IC-SBA	29	5	1	7	7.1	36.4	25.7	4.0	0	4.8	0.53
RF-085-00-IC-SBB	26	5	0	6	10.8	45.0	31.1	1.3	0	4.8	0.58
RF-085-00-IC-SBC	19	3	0	5	3.5	40.7	22.3	2.1	0	4.6	0.58
RF-090-00-IC-SBA	25	4	1	4	6.4	13.9	23.5	0.8	0	5.1	0.43
RF-090-00-IC-SBB	22	2	0	8	2.6	11.2	29.4	0.3	0	5.5	0.46
RF-090-00-IC-SBC	15	2	1	4	1.4	27.8	23.0	0.0	0	5.0	0.58
RG-128-50-IC-SBA	22	2	0	2	1.1	3.7	29.5	0.5	0	6.1	0.11
RG-128-50-IC-SBB	23	3	1	5	5.2	6.0	29.9	0.0	0.37	5.7	0.18
RG-128-50-IC-SBC	29	3	0	7	4.2	9.1	24.2	0.2	0	5.5	0.32
RG-140-00-IC-SBA	28	5	1	6	6.9	31.9	17.5	3.4	0	5.3	0.38
RG-140-00-IC-SBB	37	8	1	7	10.6	22.7	22.3	6.8	0.36	5.4	0.31
RG-140-00-IC-SBC	26	4	1	6	4.3	20.1	20.1	2.3	0	5.7	0.31
RH-142-00-IC-SBA	30	4	0	7	3.6	13.0	27.4	7.8	0	5.9	0.45
RH-142-00-IC-SBB	24	3	0	7	3.0	7.1	37.4	6.6	0.27	5.9	0.42
RH-142-00-IC-SBC	16	2	0	2	7.6	6.1	36.4	6.1	0	6.0	0.26
RH-143-00-IC-SBA	33	7	0	5	14.2	8.9	20.5	1.2	0	6.0	0.40
RH-143-00-IC-SBB	33	7	0	8	13.8	5.0	11.3	10.3	0.31	6.4	0.16
RH-143-00-IC-SBC	28	4	0	5	9.0	4.0	19.8	3.7	0	6.5	0.32
RH-151-50-IC-SBA	31	5	1	6	5.5	2.9	27.9	1.5	0	6.4	0.14
RH-151-50-IC-SBB	24	5	1	4	2.8	3.6	34.6	5.3	0	6.4	0.14
RH-151-50-IC-SBC	39	7	1	6	7.8	4.4	20.2	12.2	0	6.4	0.14
RI-166-00-SBA	21	2	0	2	1.5	14.8	34.3	1.2	0	6.6	0.23
RI-166-00-SBB	18	1	0	2	0.2	0.5	67.4	1.6	0	6.4	0.08
RI-166-00-SBC	23	2	1	4	1.2	6.2	28.2	2.5	0	6.3	0.34
RI-169-50-IC-SBA	29	4	1	5	3.2	6.8	19.5	2.4	0	6.1	0.24
RI-169-50-IC-SBB	27	3	0	5	0.9	2.4	43.8	2.6	0	6.2	0.06
RI-169-50-IC-SBC	28	1	1	4	0.3	6.1	24.4	2.9	0	6.4	0.27
RK-201-00-IC-SBA	32	10	1	6	24.3	11.4	20.0	1.4	0	5.7	0.26
RK-201-00-IC-SBB	24	5	0	4	16.3	9.2	14.2	0.7	0	6.4	0.25
RK-201-00-IC-SBC	25	5	1	4	20.8	12.8	24.8	0.8	0	5.7	0.15
RM-285-00-IC-SBA	28	7	1	4	9.8	18.4	41.7	2.4	0	5.5	0.30
RM-285-00-IC-SBB	31	7	1	5	12.3	8.8	34.2	4.5	0	5.8	0.22
RM-285-00-IC-SBC	29	5	1	5	3.0	11.2	25.0	0.3	0	5.8	0.30
TR-Ref-01-SBA	32	6	1	5	27.1	15.6	14.6	3.1	3.13	4.8	0.10
TR-Ref-01-SBB	39	6	1	10	21.5	28.7	12.0	4.0	0.80	4.8	0.33
TR-Ref-01-SBC	36	5	1	11	9.9	65.3	26.9	1.7	0	4.0	0.65
TR-Ref-02-SBA	43	8	1	6	34.9	7.8	19.2	11.8	0	5.3	0.10
TR-Ref-02-SBB	32	8	1	5	32.8	10.9	20.1	7.5	0	5.3	0.06
TR-Ref-02-SBC	34	8	1	8	32.8	24.0	18.6	4.9	0	4.8	0.21
CR-Ref-01-IC-SBA	32	6	1	7	27.7	12.8	25.7	0.0	0	5.0	0.28
CR-Ref-01-IC-SBB	16	2	0	6	6.1	28.0	31.7	0.0	0	4.5	0.78

Table 4-1a. Summary of Metric Results for Grab Samples

Location	Taxa Richness	# of Mayfly Taxa	# of Stonefly Taxa	# of Caddisfly Taxa	% Mayfly Comp	% Caddisfly Comp	% Dominant Taxon	% Isopods, Snails, Leeches	% Surface Dependent	HBI	Ratio of Filterers/Total
CR-Ref-01-IC-SBC	20	2	1	6	8.1	50.3	33.1	0.0	0	3.6	0.79
CR-Ref-02-IC-SBA	16	4	0	3	22.6	6.0	42.9	0.0	3.57	6.6	0.04
CR-Ref-02-IC-SBB	18	6	0	1	25.5	1.0	29.4	0.0	12.75	6.3	0.10
CR-Ref-02-IC-SBC	26	7	0	2	42.7	2.7	21.3	0.7	9.33	5.8	0.07
RB-013+50-SBA	16	4	0	3	22.6	6.0	42.9	0.0	3.57	6.6	0.07
RB-013+50-SBB	20	3	0	1	2.4	0.6	29.1	1.8	22.42	6.7	0.11
RB-013+50-SBC	22	2	0	0	1.2	0.0	17.3	3.5	7.51	6.1	0.10
RB-013-00-IC-SBA	32	7	1	4	15.2	3.0	17.6	7.3	0.00	6.0	0.19
RB-013-00-IC-SBB	44	8	1	4	19.4	2.5	11.1	3.6	7.89	5.7	0.18
RB-013-00-IC-SBC	35	5	0	5	5.0	2.9	21.2	1.2	0.00	6.1	0.19
Summary Results: Location Specific											
RE-062-00 MEAN	38	5	1	9	17.5	36.4	21.7	2.7	0.1	4.6	0.6
RE-062-00 SD	6.8	1.5	0.6	1.0	4.9	5.8	8.7	1.4	0.1	0.4	0.1
RE-077-50 MEAN	30	5	0	6	8.1	8.0	38.8	2.5	0	5.9	0.2
RE-077-50 SD	6.1	1.2	0.6	0.6	5.0	5.1	10.4	1.3	0	0.5	0.1
RF-085-00 MEAN	25	4	0	6	7.1	40.7	26.4	2.5	0	4.7	0.6
RF-085-00 SD	5.1	1.2	0.6	1.0	3.7	4.3	4.4	1.4	0	0.1	0.0
RF-090-00 MEAN	21	3	1	5	3.5	17.6	25.3	0.4	0	5.2	0.5
RF-090-00 SD	5.1	1.2	0.6	2.3	2.6	8.9	3.6	0.4	0	0.3	0.1
RG-128-50 MEAN	25	3	0	5	3.5	6.2	27.9	0.2	0.1	5.8	0.2
RG-128-50 SD	3.8	0.6	0.6	2.5	2.2	2.7	3.1	0.3	0.2	0.3	0.1
RG-140-00 MEAN	30	6	1	6	7.3	24.9	20.0	4.1	0.1	5.5	0.3
RG-140-00 SD	5.9	2.1	0.0	0.6	3.2	6.2	2.4	2.3	0.2	0.2	0.0
RH-142-00 MEAN	23	3	0	5	4.7	8.7	33.7	6.8	0.1	5.9	0.4
RH-142-00 SD	7.0	1.0	0.0	2.9	2.5	3.8	5.5	0.9	0.2	0.0	0.1
RH-143-00 MEAN	31	6	0	6	12.3	6.0	17.2	5.1	0.1	6.3	0.3
RH-143-00 SD	2.9	1.7	0.0	1.7	2.9	2.6	5.1	4.7	0.2	0.2	0.1
RH-151-50 MEAN	31	6	1	5	5.4	3.6	27.6	6.3	0	6.4	0.1
RH-151-50 SD	7.5	1.2	0.0	1.2	2.5	0.7	7.2	5.4	0	0.0	0.0
RI-166-00 MEAN	21	2	0	3	1.0	7.2	43.3	1.8	0	6.5	0.2
RI-166-00 SD	2.5	0.6	0.6	1.2	0.7	7.2	21.1	0.7	0	0.1	0.1
RI-169-50 MEAN	28	3	1	5	1.4	5.1	29.2	2.6	0	6.2	0.2
RI-169-50 SD	1.0	1.5	0.6	0.6	1.5	2.4	12.8	0.2	0	0.2	0.1
RK-201-00 MEAN	27	7	1	5	20.5	11.1	19.7	1.0	0	5.9	0.2
RK-201-00 SD	4.4	2.9	0.6	1.2	4.0	1.8	5.3	0.4	0	0.4	0.1
RM-285-00 MEAN	29	6	1	5	8.4	12.8	33.6	2.4	0	5.7	0.3
RM-285-00 SD	1.5	1.2	0.0	0.6	4.8	5.0	8.4	2.1	0	0.2	0.0
TR-Ref-01 MEAN	36	6	1	9	19.5	36.6	17.8	3.0	1.3	4.5	0.4
TR-Ref-01 SD	3.5	0.6	0.0	3.2	8.8	25.8	8.0	1.1	1.6	0.5	0.3
TR-Ref-02 MEAN	36	8	1	6	33.5	14.3	19.3	8.1	0	5.1	0.1
TR-Ref-02 SD	5.9	0.0	0.0	1.5	1.2	8.6	0.8	3.5	0	0.3	0.1
CR-Ref-01 MEAN	23	3	1	6	14.0	30.4	30.2	0.0	0	4.4	0.6
CR-Ref-01 SD	8.3	2.3	0.6	0.6	11.9	18.9	3.9	0.0	0	0.7	0.3
CR-Ref-02 MEAN	20	6	0	2	30.3	3.2	31.2	0.2	8.5	6.2	0.1
CR-Ref-02 SD	5.3	1.5	0.0	1.0	10.8	2.5	10.9	0.4	4.6	0.4	0.0
RB-013+50 MEAN	19	3	0	1	8.7	2.2	29.8	1.8	11.2	6.5	0.1
RB-013+50 SD	3.1	1.0	0.0	1.5	12.0	3.3	12.8	1.7	9.9	0.3	0.0
RB-013-00 MEAN	37	7	1	4	13.2	2.8	16.6	4.0	2.6	6.0	0.2
RB-013-00 SD	6.2	1.5	0.6	0.6	7.4	0.3	5.1	3.1	4.6	0.2	0.0

Table 4-1a. Summary of Metric Results for Grab Samples

Location	Taxa Richness	# of Mayfly Taxa	# of Stonefly Taxa	# of Caddisfly Taxa	% Mayfly Comp	% Caddisfly Comp	% Dominant Taxon	% Isopods, Snails, Leeches	% Surface Dependent	HBI	Ratio of Filterers/Total
Summary Results: Reach Specific											
Reach E MEAN	34	5	1	7	12.8	22.2	30.3	2.6	0.1	5.3	0.4
Reach E SD	7.3	1.2	0.5	2.0	6.8	16.3	12.7	1.2	0.1	0.8	0.2
Reach F MEAN	23	4	1	6	5.3	29.1	25.8	1.4	0	5.0	0.5
Reach F SD	3.8	1.3	0.5	1.6	3.3	15.8	3.8	1.4	0	0.3	0.1
Reach G MEAN	28	4	1	6	5.4	15.6	23.9	2.2	0.1	5.6	0.3
Reach G SD	5.4	2.1	0.5	1.9	3.2	11.1	5.0	2.6	0.2	0.3	0.1
Reach H MEAN	29	5	0	6	7.5	6.1	26.2	6.1	0.1	6.2	0.3
Reach H SD	6.7	1.8	0.5	1.8	4.3	3.2	8.9	3.7	0.1	0.2	0.1
Reach I MEAN	24	2	1	4	1.2	6.1	36.3	2.2	0	6.3	0.2
Reach I SD	4.4	1.2	0.5	1.4	1.1	4.9	17.4	0.7	0	0.2	0.1
Reach K MEAN	27	7	1	5	20.5	11.1	19.7	1.0	0	5.9	0.2
Reach K SD	4.4	2.9	0.6	1.2	4.0	1.8	5.3	0.4	0	0.4	0.1
Reach M MEAN	29	6	1	5	8.4	12.8	33.6	2.4	0	5.7	0.3
Reach M SD	1.5	1.2	0.0	0.6	4.8	5.0	8.4	2.1	0	0.2	0.0
TR-Ref MEAN	36	7	1	8	26.5	25.4	18.6	5.5	0.7	4.8	0.2
TR-Ref SD	4.3	1.3	0.0	2.6	9.5	21.1	5.1	3.6	1.3	0.5	0.2
CR-Ref MEAN	21	5	0	4	22.1	16.8	30.7	0.1	4.3	5.3	0.3
CR-Ref SD	6.4	2.2	0.5	2.5	13.5	19.2	7.3	0.3	5.5	1.1	0.4
Reach A/B MEAN	28	5	0	3	11.0	2.5	23.2	2.9	6.9	6.2	0.1
Reach A/B SD	10.6	2.3	0.5	1.9	9.3	2.1	11.3	2.5	8.4	0.4	0.1
Composite Reference MEAN	29	5	1	5	19.8	14.9	24.1	2.8	3.9	5.4	0.2
Composite Reference SD	9.4	2.1	0.5	3.0	12.3	18.3	9.4	3.3	6.1	0.9	0.2

HBI: Hilsenhoff biotic index

SD: standard deviation

Table 4-1b. Summary of EPA Metric Results for Hester-Dendy Samples

Location	Taxa Richness	# of Mayfly Taxa	# of Stonefly Taxa	# of Caddisfly Taxa	% Mayfly Comp	% Caddisfly Comp	% Dominant Taxon	% Isopods, Snails, Leeches	% Surface Dependent	HBI	Ratio of Filterers/Total
RE-061-00-HD1	32	5	2	7	2.6	10.6	33.5	0.2	0	5.7	0.19
RE-061-00-HD2	31	3	2	5	1.8	9.0	29.4	0.2	0	6.0	0.40
RE-061-00-HD3	22	1	1	2	1.1	9.5	22.1	3.2	0	6.0	0.24
RE-061-00-HD4	29	2	2	5	0.8	13.7	22.7	0.8	0	6.3	0.29
RE-061-00-HD5	29	3	1	4	2.4	10.7	27.4	1.2	0	6.0	0.18
RE-062-00-HD1	35	5	3	6	4.0	9.4	26.5	0.3	0.14	4.4	0.35
RE-062-00-HD2	41	6	3	9	8.4	14.3	32.9	0.1	0.13	5.2	0.47
RE-062-00-HD3	37	8	2	7	6.0	4.7	25.0	0.9	0	4.6	0.30
RE-062-00-HD4	37	5	2	6	4.2	5.9	21.3	0.5	0	5.1	0.29
RE-062-00-HD5	38	5	3	7	2.0	6.2	33.1	0.4	0	6.1	0.22
RE-073-00-HD1	28	1	1	3	0.3	1.1	50.7	0.3	0	6.6	0.12
RE-073-00-HD2	26	1	1	2	0.2	1.3	42.2	0.2	0	6.8	0.16
RE-073-00-HD5	30	4	1	4	1.0	3.1	37.8	0.2	0	6.3	0.10
RF-082-00-HD1	25	1	1	3	0.3	0.9	48.1	2.6	0	6.8	0.05
RF-082-00-HD2	23	1	2	0	0.6	0.0	23.9	0.0	0	6.4	0.16
RF-082-00-HD3	16	0	2	1	0.0	1.4	21.7	0.0	0	5.9	0.32
RF-082-00-HD4	19	1	1	3	0.3	0.9	33.6	0.3	0	6.1	0.04
RF-082-00-HD5	27	4	1	6	3.3	14.7	28.8	0.2	0	5.3	0.46
RG-136-00-HD1	32	5	1	4	3.1	3.6	27.6	1.6	0	5.2	0.32
RG-136-00-HD2	29	4	2	5	4.7	5.7	24.4	1.4	0	5.0	0.33
RG-136-00-HD3	32	6	2	7	4.2	6.7	29.7	0.5	0	4.9	0.33
RG-136-00-HD4	28	4	2	5	2.2	1.8	21.5	5.2	0	5.7	0.21
RG-136-00-HD5	25	4	1	4	2.3	2.7	24.3	3.8	0	5.5	0.15
RG-137-50-HD1	25	3	2	4	2.6	6.2	39.7	0.2	0	6.5	0.23
RG-137-50-HD2	28	3	2	5	1.1	1.2	33.2	0.0	0	6.4	0.34
RG-137-50-HD3	22	4	2	2	2.6	0.5	42.6	0.1	0	6.6	0.32
RG-137-50-HD4	26	5	2	5	1.4	2.6	38.6	0.3	0	6.5	0.29
RG-137-50-HD5	28	6	2	7	4.8	1.5	46.9	1.0	0	6.6	0.20
RH-143-00-HD1	24	5	2	7	1.7	2.9	36.0	0.0	0	5.8	0.40
RH-143-00-HD2	28	5	2	7	2.0	4.7	51.9	0.3	0	6.6	0.31
RH-143-00-HD3	39	6	1	8	2.9	4.2	42.6	0.2	0	6.4	0.25
RH-144-50-HD1	21	4	2	2	3.1	0.9	58.0	0.0	0	6.7	0.15
RH-144-50-HD2	18	6	1	3	3.4	3.1	37.5	0.0	0	6.2	0.35
RH-144-50-HD3	29	2	2	6	2.1	0.6	36.3	0.1	0	6.6	0.33
RH-144-50-HD4	25	4	2	3	2.4	0.8	29.2	0.0	0	6.0	0.28
RH-144-50-HD5	25	5	2	3	2.8	2.1	30.6	0.2	0	5.8	0.24
RH-150-00-HD1	17	2	1	1	0.5	0.2	57.5	0.0	0	7.2	0.12
RH-150-00-HD2	22	4	2	0	1.3	0.0	55.6	0.2	0	7.2	0.15
RH-150-00-HD3	27	4	2	3	1.6	0.4	48.0	0.1	0	6.8	0.15
RH-150-00-HD4	19	3	1	2	1.5	0.2	47.1	0.2	0	6.8	0.27
RH-150-00-HD5	25	3	1	4	2.2	2.1	51.3	0.5	0	6.8	0.17
RI-164-00-HD1	22	4	1	5	1.9	1.2	61.2	0.0	0	7.1	0.13
RI-164-00-HD2	23	3	2	4	1.4	1.8	63.9	0.0	0	7.2	0.11
RI-164-00-HD3	31	8	1	8	1.9	3.7	56.4	0.0	0	6.8	0.17
RI-164-00-HD4	26	5	1	6	5.2	11.0	49.0	0.0	0	6.6	0.23
RI-164-00-HD5	23	2	1	5	2.9	6.3	29.1	0.0	0	6.0	0.42
RI-164-50-HD1	24	2	0	0	0.3	0.0	56.2	0.6	0	7.3	0.06
RI-164-50-HD2	21	2	0	0	0.3	0.0	65.7	2.2	0	7.6	0.06
RI-164-50-HD3	27	1	1	1	0.1	0.1	59.0	1.2	0.14	7.0	0.06
RI-164-50-HD4	21	1	1	1	0.1	0.1	51.3	0.6	0	6.9	0.19
RI-164-50-HD5	17	0	0	0	0.0	0.0	59.1	1.3	0	7.3	0.05
RI-168-50-HD1	26	2	1	2	0.6	3.3	26.9	2.7	0.19	6.5	0.24
RI-168-50-HD2	25	2	1	3	0.7	2.8	47.0	1.7	0	7.0	0.19
RI-168-50-HD3	30	2	1	4	0.3	2.8	19.4	5.5	0	6.6	0.22
RI-168-50-HD4	24	2	1	6	0.7	10.8	27.2	3.5	0	6.5	0.23
RI-168-50-HD5	25	2	0	4	0.4	5.8	40.6	3.9	0	6.8	0.21
RK-201-00-HD1	20	2	1	5	0.6	20.4	17.9	0.0	0	5.0	0.32
RK-201-00-HD2	15	2	1	3	2.8	1.9	40.7	0.0	0	6.3	0.16
RK-201-00-HD3	19	4	1	2	2.2	3.5	24.0	0.0	0	5.4	0.16
RK-201-00-HD4	24	5	1	3	7.6	2.5	27.9	0.0	0	5.8	0.09
RK-201-00-HD5	20	4	1	3	3.1	7.6	32.5	0.0	0	5.9	0.20
RM-285-00-HD1	16	3	1	4	1.9	23.9	28.0	0.0	0	5.8	0.52
RM-285-00-HD2	18	3	1	4	1.0	22.8	21.9	0.0	0	5.4	0.38
RM-285-00-HD3	20	2	2	4	1.4	12.0	27.2	0.0	0	4.7	0.32
RM-285-00-HD4	20	4	1	5	0.9	6.4	29.1	0.2	0	5.6	0.20
RM-285-00-HD5	24	3	2	3	1.2	5.8	25.5	0.0	0	5.6	0.24
TR-REF-01-HD1	28	3	1	4	11.4	5.4	26.1	1.1	0	4.6	0.13
TR-REF-01-HD2	23	2	1	6	15.6	11.7	35.1	1.5	0	4.1	0.08
TR-REF-01-HD3	26	3	2	7	8.1	13.0	38.6	0.3	0	3.7	0.14
TR-REF-01-HD4	25	3	1	4	12.4	8.8	24.1	2.9	0	4.1	0.15
TR-REF-01-HD5	25	3	1	4	22.5	15.6	15.0	0.6	0	4.6	0.18
TR-REF-02-HD1	27	4	2	5	33.2	10.3	29.4	1.9	0	4.0	0.11
TR-REF-02-HD2	34	5	2	6	30.1	21.1	23.8	0.6	0	4.3	0.23
TR-REF-02-HD3	23	2	1	6	39.6	19.6	38.6	0.5	0	4.1	0.22
TR-REF-02-HD4	23	3	1	6	43.0	18.3	37.3	0.4	0	4.3	0.20
TR-REF-02-HD5	17	2	1	4	24.4	15.6	20.0	0.0	0	4.8	0.26
CR-REF-01-HD1	32	7	2	6	5.3	5.0	56.1	0.0	0	5.7	0.61
CR-REF-01-HD2	33	8	2	9	4.6	8.8	74.2	0.0	0	5.6	0.83
CR-REF-01-HD3	23	4	3	2	10.6	2.7	28.2	0.8	0	7.0	0.18
CR-REF-01-HD4	21	3	1	4	3.0	2.5	56.6	0.5	0	5.7	0.59

Table 4-1b. Summary of EPA Metric Results for Hester-Dendy Samples

Location	Taxa Richness	# of Mayfly Taxa	# of Stonefly Taxa	# of Caddisfly Taxa	% Mayfly Comp	% Caddisfly Comp	% Dominant Taxon	% Isopods, Snails, Leeches	% Surface Dependent	HBI	Ratio of Filterers/Total
CR-REF-01-HD5	29	8	3	2	6.1	2.2	55.3	0.5	0	5.7	0.58
CR-REF-02-HD1	29	8	2	4	19.2	2.7	24.2	0.5	0	5.9	0.20
CR-REF-02-HD2	30	6	3	2	6.8	0.7	21.6	0.0	0	6.2	0.23
CR-REF-02-HD3	33	8	2	7	2.8	3.6	28.7	0.8	0	6.4	0.38
CR-REF-02-HD4	35	6	3	6	6.6	2.5	21.8	1.1	0	6.8	0.14
CR-REF-02-HD5	35	5	1	5	11.8	2.4	18.9	4.3	0	6.3	0.19
RA-003-50-HD1	30	4	2	3	6.0	2.2	31.5	0.7	0	6.0	0.35
RA-003-50-HD2	26	2	1	2	2.8	2.8	27.5	0.9	0	7.6	0.06
RA-003-50-HD3	32	5	3	4	3.8	2.8	12.6	0.3	0	5.9	0.07
RA-003-50-HD4	27	3	2	1	2.7	0.3	23.1	0.3	0	5.7	0.23
RA-003-50-HD5	27	4	2	2	2.0	1.1	39.4	0.3	0	6.4	0.12
RB-012-50-HD1	26	2	0	3	0.8	1.1	22.5	4.5	0.27	6.0	0.18
RB-012-50-HD2	24	3	0	1	1.6	0.4	34.8	1.2	0	6.7	0.21
RB-012-50-HD3	24	3	0	3	0.8	0.8	41.4	2.5	0	6.4	0.28
RB-012-50-HD4	21	2	0	1	0.5	0.5	26.4	2.3	0	6.1	0.12
RB-012-50-HD5	21	2	1	4	0.8	1.7	40.2	1.1	0	5.7	0.17
Summary Results: Location Specific											
RE-061-00 MEAN	29	3	2	5	1.72	10.69	27.04	1.09	0	6.01	0.26
RE-061-00 SD	3.9	1.5	0.5	1.8	0.80	1.83	4.77	1.23	0	0.20	0.09
RE-062-00 MEAN	38	6	3	7	4.90	8.11	27.77	0.42	0.05	5.10	0.33
RE-062-00 SD	2.2	1.3	0.5	1.2	2.40	3.86	5.16	0.28	0.07	0.66	0.09
RE-073-00 MEAN	28	2	1	3	0.50	1.84	43.55	0.23	0	6.56	0.13
RE-073-00 SD	2.0	1.7	0.0	1.0	0.42	1.09	6.56	0.06	0.0	0.26	0.03
RF-082-00 MEAN	22	1	1	3	0.88	3.56	31.24	0.64	0	6.09	0.21
RF-082-00 SD	4.5	1.5	0.5	2.3	1.34	6.22	10.49	1.13	0	0.57	0.18
RG-136-00 MEAN	29	5	2	5	3.30	4.12	25.49	2.50	0	5.28	0.27
RG-136-00 SD	2.9	0.9	0.5	1.2	1.10	2.07	3.19	1.94	0	0.33	0.08
RG-137-50 MEAN	26	4	2	5	2.51	2.40	40.20	0.31	0	6.53	0.28
RG-137-50 SD	2.5	1.3	0.0	1.8	1.43	2.25	5.04	0.38	0	0.09	0.06
RH-143-00 MEAN	30	5	2	7	2.20	3.92	43.51	0.15	0	6.26	0.32
RH-143-00 SD	7.8	0.6	0.6	0.6	0.65	0.93	8.03	0.14	0	0.45	0.08
RH-144-50 MEAN	24	4	2	3	2.79	1.50	38.32	0.06	0	6.28	0.27
RH-144-50 SD	4.2	1.5	0.4	1.5	0.51	1.06	11.54	0.10	0	0.37	0.08
RH-150-00 MEAN	22	3	1	2	1.41	0.59	51.90	0.20	0	6.95	0.17
RH-150-00 SD	4.1	0.8	0.5	1.6	0.63	0.85	4.59	0.18	0	0.23	0.06
RI-164-00 MEAN	25	4	1	6	2.65	4.78	51.93	0	0	6.73	0.21
RI-164-00 SD	3.7	2.3	0.4	1.5	1.50	3.99	13.93	0	0	0.49	0.13
RI-164-50 MEAN	22	1	0	0	0.19	0.06	58.26	1.18	0.03	7.23	0.08
RI-164-50 SD	3.7	0.8	0.5	0.5	0.14	0.08	5.20	0.65	0.06	0.28	0.06
RI-168-50 MEAN	26	2	1	4	0.56	5.11	32.22	3.46	0.04	6.67	0.22
RI-168-50 SD	2.3	0.0	0.4	1.5	0.17	3.41	11.26	1.41	0.09	0.21	0.02
RK-201-00 MEAN	20	3	1	3	3.25	7.20	28.62	0	0	5.68	0.18
RK-201-00 SD	3.2	1.3	0.0	1.1	2.63	7.74	8.64	0	0	0.49	0.08
RM-285-00 MEAN	20	3	1	4	1.29	14.17	26.32	0.04	0	5.38	0.33
RM-285-00 SD	3.0	0.7	0.5	0.7	0.41	8.72	2.79	0.10	0	0.42	0.13
TR-REF-01 MEAN	25	3	1	5	14.01	10.91	27.77	1.28	0	4.23	0.14
TR-REF-01 SD	1.8	0.4	0.4	1.4	5.45	3.94	9.35	1.02	0	0.38	0.04
TR-REF-02 MEAN	25	3	1	5	34.08	16.97	29.83	0.68	0	4.30	0.20
TR-REF-02 SD	6.3	1.3	0.5	0.9	7.41	4.25	8.15	0.73	0	0.34	0.06
CR-REF-01 MEAN	28	6	2	5	5.93	4.26	54.09	0.35	0	5.94	0.56
CR-REF-01 SD	5.4	2.3	0.8	3.0	2.84	2.79	16.45	0.34	0	0.60	0.23
CR-REF-02 MEAN	32	7	2	5	9.45	2.38	23.02	1.36	0	6.33	0.23
CR-REF-02 SD	2.8	1.3	0.8	1.9	6.34	1.04	3.68	1.71	0	0.33	0.09
RA-003-50 MEAN	28	4	2	2	3.45	1.84	26.80	0.53	0	6.31	0.17
RA-003-50 SD	2.5	1.1	0.7	1.1	1.57	1.09	9.96	0.28	0	0.78	0.12
RB-012-50 MEAN	23	2	0	2	0.91	0.90	33.06	2.33	0.05	6.17	0.19
RB-012-50 SD	2.2	0.5	0.4	1.3	0.40	0.51	8.39	1.39	0.12	0.39	0.06

Table 4-1b. Summary of EPA Metric Results for Hester-Dendy Samples

Location	Taxa Richness	# of Mayfly Taxa	# of Stonefly Taxa	# of Caddisfly Taxa	% Mayfly Comp	% Caddisfly Comp	% Dominant Taxon	% Isopods, Snails, Leeches	% Surface Dependent	HBI	Ratio of Filterers/Total
Summary Results: Reach Specific											
Reach E MEAN	32	4	2	5	2.66	7.66	31.13	0.64	0.02	5.79	0.25
Reach E SD	5.4	2.2	0.8	2.1	2.41	4.32	8.59	0.82	0.05	0.73	0.11
Reach F MEAN	22	1	1	3	0.88	3.56	31.24	0.64	0	6.09	0.21
Reach F SD	4.5	1.5	0.5	2.3	1.34	6.22	10.49	1.13	0	0.57	0.18
Reach G MEAN	28	4	2	5	2.91	3.26	32.85	1.41	0	5.90	0.27
Reach G SD	3.1	1.1	0.4	1.5	1.28	2.23	8.71	1.75	0	0.69	0.07
Reach H MEAN	25	4	2	4	2.12	1.71	44.74	0.14	0	6.53	0.24
Reach H SD	5.8	1.3	0.5	2.5	0.83	1.59	10.05	0.15	0	0.46	0.09
Reach I MEAN	24	3	1	3	1.13	3.32	47.47	1.55	0.02	6.88	0.17
Reach I SD	3.5	1.9	0.6	2.5	1.38	3.69	15.20	1.70	0.06	0.41	0.10
Reach K MEAN	20	3	1	3	3.25	7.20	28.62	0	0	5.68	0.18
Reach K SD	3.2	1.3	0.0	1.1	2.63	7.74	8.64	0	0	0.49	0.08
Reach M MEAN	20	3	1	4	1.29	14.17	26.32	0.04	0	5.38	0.33
Reach M SD	3.0	0.7	0.5	0.7	0.41	8.72	2.79	0.10	0	0.42	0.13
TR-Ref MEAN	25	3	1	5	24.04	13.94	28.80	0.98	0	4.27	0.17
TR-Ref SD	4.4	0.9	0.5	1.1	12.23	5.01	8.34	0.89	0	0.34	0.06
CR-Ref MEAN	30	6	2	5	7.69	3.32	38.55	0.86	0	6.13	0.39
CR-Ref SD	4.8	1.8	0.8	2.4	4.99	2.22	19.86	1.28	0	0.50	0.24
Reach A/B MEAN	26	3	1	2	2.18	1.37	29.93	1.43	0.03	6.24	0.18
Reach A/B SD	3.5	1.1	1.1	1.2	1.72	0.94	9.29	1.34	0.08	0.58	0.09
Composite Reference I	27	4	2	4	11.3	6.2	32.4	1.1	0.0	5.5	0.2
Composite Reference S	4.6	2.0	0.9	2.0	12.0	6.4	13.8	1.2	0.0	1.0	0.2

SD: standard deviation

EPA: United States Environmental Protection Agency

HBI: Hilsenhoff biotic index

Table 4-1c. Summary of EPA/DNRE Metric Results for Sweep Samples

Location	Taxa Richness	# of Mayfly Taxa	# of Stonefly Taxa	# of Caddisfly Taxa	% Mayfly Comp	% Caddisfly Comp	% Dominant Taxon	% Isopods, Snails, Leeches	% Surface Dependent	HBI	Ratio of Filterers/ Total
RE-062-00-IC-SP1	39	5	0	8	8.3	42.6	15.5	0.3	0	4.7	0.53
RE-077-50-IC-SP1	41	8	1	7	6.0	10.7	29.6	4.7	0	5.9	0.24
RF-085-00-IC-SP1	33	6	1	5	5.5	32.0	18.9	1.1	0	4.5	0.55
RG-140-00-IC-SP1	37	6	0	9	7.5	27.4	21.6	2.1	0	5.6	0.40
RH-153-50-IC-SP1	40	6	1	10	24.8	10.0	30.5	5.9	0	5.4	0.21
RI-169-50-IC-SP1	37	5	0	7	4.5	8.9	28.9	6.6	0	6.1	0.23
RK-201-00-IC-SP1	40	6	1	8	15.7	12.0	27.4	0.8	0.3	6.2	0.23
RM-285-00-IC-SP1	40	6	1	5	13.4	31.0	19.5	4.1	0	5.8	0.35
TR-Ref-01-SP1	47	9	1	7	8.0	39.5	25.4	3.6	0.5	4.6	0.42
TR-Ref-02-SP1	38	7	1	7	23.8	29.4	18.0	5.4	0	4.6	0.29
CR-Ref-01-IC-SP1	42	7	1	9	19.5	30.9	13.2	2.0	0	4.6	0.41
CR-Ref-02-IC-SP1	42	7	1	9	17.7	25.7	16.7	2.7	0.8	4.7	0.29
RA-Ref-01-IC-SP1	36	5	0	2	1.9	0.5	39.5	3.8	2.1	6.9	0.04
RB-013-00-IC-SP1	39	7	0	4	5.4	2.2	18.5	15.1	0.2	6.0	0.05
Composite Reference MEAN	41	7	1	6	12.7	21.4	21.9	5.4	0.6	5.2	0.3
Composite Reference SD	3.9	1.3	0.5	2.8	8.8	16.2	9.5	4.9	0.8	1.0	0.2

EPA: United States Environmental Protection Agency

DNRE: Michigan Department of Natural Resources and Environment

HBI: Hilsenhoff biotic index

Table 4-2a: Dominant Taxon from Grabs Samples

Location ID	Species	Common Name
TR-Ref-01-SBA	Gammarus fasciatus	sideswimmer (amphipod)
TR-Ref-01-SBB	Maccaffertium/Dubiraphia	mayfly/riffle beetle
TR-Ref-01-SBC	Hydropsyche sp.	caddisfly
TR-Ref-02-SBA	Maccaffertium sp.	mayfly
TR-Ref-02-SBB	Dugesia/Maccaffertium	flat worm/mayfly
TR-Ref-02-SBC	Maccaffertium sp.	mayfly
CR-Ref-01-IC-SBA	Orthocladus cplx.	midge
CR-Ref-01-IC-SBB	Rheotanytarsus sp.	midge
CR-Ref-01-IC-SBC	Hydropsyche phalerata	caddisfly
CR-Ref-02-IC-SBA	Nais sp.	naiad worm
CR-Ref-02-IC-SBB	Nais sp.	naiad worm
CR-Ref-02-IC-SBC	Baetisca sp.	mayfly
RA-Ref-02-SBA	Nais sp.	naiad worm
RA-Ref-02-SBB	Polypedilum sp.	midge
RA-Ref-02-SBC	Tribelos juncundum	midge
RB-013-00-IC-SBA	Nais sp.	naiad worm
RB-013-00-IC-SBB	Hydracarina	water mite
RB-013-00-IC-SBC	Nais sp.	naiad worm
RE-062-00-IC-SBA	Cheumatopsyche sp.	caddisfly
RE-062-00-IC-SBB	Cheumatopsyche sp.	caddisfly
RE-062-00-IC-SBC	Simulium sp.	black fly
RE-077-50-IC-SBA	Orthocladus cplx.	midge
RE-077-50-IC-SBB	Orthocladus cplx.	midge
RE-077-50-IC-SBC	Nais/Nais bretscheri	naiad worm
RF-085-00-IC-SBA	Orthocladus cplx.	midge
RF-085-00-IC-SBB	Cheumatopsyche sp.	caddisfly
RF-085-00-IC-SBC	Orthocladus cplx.	midge
RF-090-00-IC-SBA	Simulium sp.	black fly
RF-090-00-IC-SBB	Orthocladus cplx.	midge
RF-090-00-IC-SBC	Orthocladus cplx.	midge
RG-128-50-IC-SBA	Pseudochironomus sp.	midge
RG-128-50-IC-SBB	Orthocladus sp.	midge
RG-128-50-IC-SBC	Orthocladus cplx.	midge
RG-140-00-IC-SBA	Orthocladus cx/Cric bicintus	midge
RG-140-00-IC-SBB	Orthocladus cplx.	midge
RG-140-00-IC-SBC	Nais sp.	naiad worm
RH-142-00-IC-SBA	Orthocladus cplx.	midge
RH-142-00-IC-SBB	Orthocladus sp.	midge
RH-142-00-IC-SBC	Orthocladus cplx.	midge
RH-143-00-IC-SBA	Dreissena polymorpha	zebra mussel
RH-143-00-IC-SBB	Rheotanytarsus sp.	midge
RH-143-00-IC-SBC	Orthocladus sp.	midge
RH-151-50-IC-SBA	Orthocladus cplx.	midge
RH-151-50-IC-SBB	Cricotopus bicintus	midge
RH-151-50-IC-SBC	Cricotopus bicintus	midge
RI-166-00-SBA	Nais sp.	naiad worm
RI-166-00-SBB	Orthocladus cplx.	midge
RI-166-00-SBC	Orthocladus cplx.	midge
RI-169-50-IC-SBA	Orthocladus cx/Cric bicintus	midge
RI-169-50-IC-SBB	Orthocladus cplx.	midge
RI-169-50-IC-SBC	Orthocladus cplx.	midge
RK-201-00-IC-SBA	Orthocladus cplx.	midge
RK-201-00-IC-SBB	Orthocladus cplx.	midge
RK-201-00-IC-SBC	Orthocladus cplx.	midge
RM-285-00-IC-SBA	Orthocladus cplx.	midge
RM-285-00-IC-SBB	Orthocladus cplx.	midge
RM-285-00-IC-SBC	Orthocladus cplx.	midge

Table 4-2b: Dominant Taxon from Hester Dendy Samples

Location	Species	Common Name
TR-REF-01-HD1	Gammarus fasciatus	sideswimmer (amphipod)
TR-REF-01-HD2	Gammarus fasciatus	sideswimmer (amphipod)
TR-REF-01-HD3	Taeniopteryx sp.	stonefly
TR-REF-01-HD4	Gammarus fasciatus	sideswimmer (amphipod)
TR-REF-01-HD5	Taeniopteryx sp.	stonefly
TR-REF-02-HD1	Gammarus fasciatus	sideswimmer (amphipod)
TR-REF-02-HD2	Gammarus fasciatus	sideswimmer (amphipod)
TR-REF-02-HD3	Maccaffertium sp.	mayfly
TR-REF-02-HD4	Maccaffertium sp.	mayfly
TR-REF-02-HD5	Maccaffertium sp.	mayfly
CR-REF-01-HD1	Rheotanytarsus sp.	midge
CR-REF-01-HD2	Rheotanytarsus sp.	midge
CR-REF-01-HD3	Chironomus sp.	midge
CR-REF-01-HD4	Rheotanytarsus sp.	midge
CR-REF-01-HD5	Rheotanytarsus sp.	midge
CR-REF-02-HD1	Nais sp.	naiad worm
CR-REF-02-HD2	Rheotanytarsus sp.	midge
CR-REF-02-HD3	Rheotanytarsus sp.	midge
CR-REF-02-HD4	Polypedilum flavum	midge
CR-REF-02-HD5	Polypedilum flavum	midge
RA-003-50-HD1	Rheotanytarsus sp.	midge
RA-003-50-HD2	Chironomus sp.	midge
RA-003-50-HD3	Polypedilum flavum	midge
RA-003-50-HD4	Polypedilum flavum	midge
RA-003-50-HD5	Nais sp.	naiad worm
RB-012-50-HD1	Nais sp.	naiad worm
RB-012-50-HD2	Nais sp.	naiad worm
RB-012-50-HD3	Nais sp.	naiad worm
RB-012-50-HD4	Nais sp.	naiad worm
RB-012-50-HD5	Nais sp.	naiad worm
RE-061-00-HD1	Polypedilum flavum	midge
RE-061-00-HD2	Rheotanytarsus sp.	midge
RE-061-00-HD3	Nais sp.	naiad worm
RE-061-00-HD4	Nais sp.	naiad worm
RE-061-00-HD5	Polypedilum flavum	midge
RE-062-00-HD1	Taeniopteryx sp.	stonefly
RE-062-00-HD2	Rheotanytarsus sp.	midge
RE-062-00-HD3	Rheotanytarsus sp.	midge
RE-062-00-HD4	Rheotanytarsus sp.	midge
RE-062-00-HD5	Nais sp.	naiad worm
RE-073-00-HD1	Nais sp.	naiad worm
RE-073-00-HD2	Nais sp.	naiad worm
RE-073-00-HD5	Nais sp.	naiad worm
RF-082-00-HD1	Nais sp.	naiad worm
RF-082-00-HD2	Nais sp.	naiad worm
RF-082-00-HD3	P. flavum / D. neomodestus	midges
RF-082-00-HD4	Nais sp.	naiad worm
RF-082-00-HD5	Rheotanytarsus sp.	midge
RG-136-00-HD1	Rheotanytarsus sp.	midge
RG-136-00-HD2	Taeniopteryx sp.	stonefly
RG-136-00-HD3	Taeniopteryx sp.	stonefly
RG-136-00-HD4	Taeniopteryx sp.	stonefly
RG-136-00-HD5	Taeniopteryx sp.	stonefly
RG-137-50-HD1	Nais sp.	naiad worm
RG-137-50-HD2	Nais sp.	naiad worm
RG-137-50-HD3	Nais sp.	naiad worm

Table 4-2b: Dominant Taxon from Hester Dendy Samples

Location	Species	Common Name
RG-137-50-HD4	Nais sp.	naiad worm
RG-137-50-HD5	Nais sp.	naiad worm
RH-143-00-HD1	Rheotanytarsus sp.	midge
RH-143-00-HD2	Nais sp.	naiad worm
RH-143-00-HD3	Nais sp.	naiad worm
RH-144-50-HD1	Nais sp.	naiad worm
RH-144-50-HD2	Nais sp.	naiad worm
RH-144-50-HD3	Nais sp.	naiad worm
RH-144-50-HD4	Nais sp.	naiad worm
RH-144-50-HD5	Nais sp.	naiad worm
RH-150-00-HD1	Nais sp.	naiad worm
RH-150-00-HD2	Nais sp.	naiad worm
RH-150-00-HD3	Nais sp.	naiad worm
RH-150-00-HD4	Nais sp.	naiad worm
RH-150-00-HD5	Nais sp.	naiad worm
RI-164-00-HD1	Nais sp.	naiad worm
RI-164-00-HD2	Nais sp.	naiad worm
RI-164-00-HD3	Nais sp.	naiad worm
RI-164-00-HD4	Nais sp.	naiad worm
RI-164-00-HD5	Nais sp.	naiad worm
RI-164-50-HD1	Nais sp.	naiad worm
RI-164-50-HD2	Nais sp.	naiad worm
RI-164-50-HD3	Nais sp.	naiad worm
RI-164-50-HD4	Nais sp.	naiad worm
RI-164-50-HD5	Nais sp.	naiad worm
RI-168-50-HD1	Nais sp.	naiad worm
RI-168-50-HD2	Nais sp.	naiad worm
RI-168-50-HD3	Nais sp.	naiad worm
RI-168-50-HD4	Nais sp.	naiad worm
RI-168-50-HD5	Nais sp.	naiad worm
RK-201-00-HD1	Orthocladius cplx.	midge
RK-201-00-HD2	Nais sp.	naiad worm
RK-201-00-HD3	Polypedilum flavum	midge
RK-201-00-HD4	Nais sp.	naiad worm
RK-201-00-HD5	Nais sp.	naiad worm
RM-285-00-HD1	Nais sp.	naiad worm
RM-285-00-HD2	Nais sp.	naiad worm
RM-285-00-HD3	Taeniopteryx sp.	stonefly
RM-285-00-HD4	Nais sp.	naiad worm
RM-285-00-HD5	Polypedilum flavum	midge

Table 4-2c: Dominant Taxon from Sweep Samples

Location	Species	Common Name
TR-Ref-01-SP1	Hydropsyche sp.	caddisfly
TR-Ref-02-SP1	Maccaffertium sp.	mayfly
CR-Ref-01-IC-SP1	Hydropsyche phalerata	caddisfly
CR-Ref-02-IC-SP1	Gammarus fasciatus	sideswimmer (amphipod)
RA-Ref-01-IC-SP1	Hyaella azteca	sideswimmer (amphipod)
RB-013-00-IC-SP1	Gammarus fasciatus	sideswimmer (amphipod)
RE-062-00-IC-SP1	Cheumatopsyche sp.	caddisfly
RE-077-50-IC-SP1	Cricotopus bicintus	midge
RF-085-00-IC-SP1	Rheotanytarsus sp.	midge
RG-140-00-IC-SP1	Cricotopus bicintus	midge
RH-153-50-IC-SP1	Cricotopus bicintus	midge
RI-169-50-IC-SP1	Cricotopus bicintus	midge
RK-201-00-IC-SP1	Cricotopus bicintus	midge
RM-285-00-IC-SP1	Cheumatopsyche sp.	caddisfly

Table 4-3a. EPA Multi-Metric Scoring for Grab Samples Compared to the Composite Reference: Reach and Locations

Location	Biological Metrics										
	Taxa Richness	# of Mayfly Taxa	# of Stonefly Taxa	# of Caddisfly Taxa	% Mayfly Comp	% Caddisfly Comp	% Dominant Taxon	% Isopods, Snails, Leeches	% Surface Dependent	HBI	Ratio of Filterers/Total
RE-062-00-IC-SBA	46	7	1	10	13.4	31.1	11.6	1.9	0.3	4.9	0.5
RE-062-00-IC-SBB	33	4	0	8	22.9	42.7	26.4	4.2	0.1	4.6	0.5
RE-062-00-IC-SBC	36	5	1	9	16.2	35.4	27.0	1.9	0.0	4.2	0.7
RE-077-50-IC-SBA	29	6	0	6	13.9	11.9	45.3	2.8	0.0	5.5	0.3
RE-077-50-IC-SBB	25	4	1	5	4.8	9.9	44.3	3.6	0.0	5.9	0.3
RE-077-50-IC-SBC	37	6	0	6	5.6	2.2	26.9	1.1	0.0	6.4	0.1
RF-085-00-IC-SBA	29	5	1	7	7.1	36.4	25.7	4.0	0.0	4.8	0.5
RF-085-00-IC-SBB	26	5	0	6	10.8	45.0	31.1	1.3	0.0	4.8	0.6
RF-085-00-IC-SBC	19	3	0	5	3.5	40.7	22.3	2.1	0.0	4.6	0.6
RF-090-00-IC-SBA	25	4	1	4	6.4	13.9	23.5	0.8	0.0	5.1	0.4
RF-090-00-IC-SBB	22	2	0	8	2.6	11.2	29.4	0.3	0.0	5.5	0.5
RF-090-00-IC-SBC	15	2	1	4	1.4	27.8	23.0	0.0	0.0	5.0	0.6
RG-128-50-IC-SBA	22	2	0	2	1.1	3.7	29.5	0.5	0.0	6.1	0.1
RG-128-50-IC-SBB	23	3	1	5	5.2	6.0	29.9	0.0	0.4	5.7	0.2
RG-128-50-IC-SBC	29	3	0	7	4.2	9.1	24.2	0.2	0.0	5.5	0.3
RG-140-00-IC-SBA	28	5	1	6	6.9	31.9	17.5	3.4	0.0	5.3	0.4
RG-140-00-IC-SBB	37	8	1	7	10.6	22.7	22.3	6.8	0.4	5.4	0.3
RG-140-00-IC-SBC	26	4	1	6	4.3	20.1	20.1	2.3	0.0	5.7	0.3
RH-142-00-IC-SBA	30	4	0	7	3.6	13.0	27.4	7.8	0.0	5.9	0.4
RH-142-00-IC-SBB	24	3	0	7	3.0	7.1	37.4	6.6	0.3	5.9	0.4
RH-142-00-IC-SBC	16	2	0	2	7.6	6.1	36.4	6.1	0.0	6.0	0.3
RH-143-00-IC-SBA	33	7	0	5	14.2	8.9	20.5	1.2	0.0	6.0	0.4
RH-143-00-IC-SBB	33	7	0	8	13.8	5.0	11.3	10.3	0.3	6.4	0.2
RH-143-00-IC-SBC	28	4	0	5	9.0	4.0	19.8	3.7	0.0	6.5	0.3
RH-151-50-IC-SBA	31	5	1	6	5.5	2.9	27.9	1.5	0.0	6.4	0.1
RH-151-50-IC-SBB	24	5	1	4	2.8	3.6	34.6	5.3	0.0	6.4	0.1
RH-151-50-IC-SBC	39	7	1	6	7.8	4.4	20.2	12.2	0.0	6.4	0.1
RI-166-00-SBA	21	2	0	2	1.5	14.8	34.3	1.2	0.0	6.6	0.2
RI-166-00-SBB	18	1	0	2	0.2	0.5	67.4	1.6	0.0	6.4	0.1
RI-166-00-SBC	23	2	1	4	1.2	6.2	28.2	2.5	0.0	6.3	0.3
RI-169-50-IC-SBA	29	4	1	5	3.2	6.8	19.5	2.4	0.0	6.1	0.2
RI-169-50-IC-SBB	27	3	0	5	0.9	2.4	43.8	2.6	0.0	6.2	0.1
RI-169-50-IC-SBC	28	1	1	4	0.3	6.1	24.4	2.9	0.0	6.4	0.3
RK-201-00-IC-SBA	32	10	1	6	24.3	11.4	20.0	1.4	0.0	5.7	0.3
RK-201-00-IC-SBB	24	5	0	4	16.3	9.2	14.2	0.7	0.0	6.4	0.2
RK-201-00-IC-SBC	25	5	1	4	20.8	12.8	24.8	0.8	0.0	5.7	0.2
RM-285-00-IC-SBA	28	7	1	4	9.8	18.4	41.7	2.4	0.0	5.5	0.3
RM-285-00-IC-SBB	31	7	1	5	12.3	8.8	34.2	4.5	0.0	5.8	0.2
RM-285-00-IC-SBC	29	5	1	5	3.0	11.2	25.0	0.3	0.0	5.8	0.3
TR-Ref-01-SBA	32	6	1	5	27.1	15.6	14.6	3.1	3.1	4.8	0.1
TR-Ref-01-SBB	39	6	1	10	21.5	28.7	12.0	4.0	0.8	4.8	0.3
TR-Ref-01-SBC	36	5	1	11	9.9	65.3	26.9	1.7	0.0	4.0	0.7
TR-Ref-02-SBA	43	8	1	6	34.9	7.8	19.2	11.8	0.0	5.3	0.1
TR-Ref-02-SBB	32	8	1	5	32.8	10.9	20.1	7.5	0.0	5.3	0.1
TR-Ref-02-SBC	34	8	1	8	32.8	24.0	18.6	4.9	0.0	4.8	0.2
CR-Ref-01-IC-SBA	32	6	1	7	27.7	12.8	25.7	0.0	0.0	5.0	0.3
CR-Ref-01-IC-SBB	16	2	0	6	6.1	28.0	31.7	0.0	0.0	4.5	0.8
CR-Ref-01-IC-SBC	20	2	1	6	8.1	50.3	33.1	0.0	0.0	3.6	0.8
CR-Ref-02-IC-SBA	16	4	0	3	22.6	6.0	42.9	0.0	3.6	6.6	0.0
CR-Ref-02-IC-SBB	18	6	0	1	25.5	1.0	29.4	0.0	12.7	6.3	0.1
CR-Ref-02-IC-SBC	26	7	0	2	42.7	2.7	21.3	0.7	9.3	5.8	0.1
RB-013+50-SBA	16	4	0	3	22.6	6.0	42.9	0.0	3.6	6.6	0.1
RB-013+50-SBB	20	3	0	1	2.4	0.6	29.1	1.8	22.4	6.7	0.1
RB-013+50-SBC	22	2	0	0	1.2	0.0	17.3	3.5	7.5	6.1	0.1
RB-013-00-IC-SBA	32	7	1	4	15.2	3.0	17.6	7.3	0.0	6.0	0.2
RB-013-00-IC-SBB	44	8	1	4	19.4	2.5	11.1	3.6	7.9	5.7	0.2
RB-013-00-IC-SBC	35	5	0	5	5.0	2.9	21.2	1.2	0.0	6.1	0.2
Composite Reference Mean	29	5	0.56	5	19.85	14.91	24.1	2.83	3.94	5.45	0.24

Table 4-3a. EPA Multi-Metric Scoring for Grab Samples Compared to the Composite Reference: Reach and Locations

Location	Biological Condition Score										
	Taxa Richness	# of Mayfly Taxa	# of Stonefly Taxa	# of Caddisfly Taxa	% Mayfly Comp	% Caddisfly Comp	% Dominant Taxon	% Isopods, Snails, Leeches	% Surface Dependent	HBI	Ratio of Filterers/Total
RE-062-00-IC-SBA	161%	130%	180%	207%	13%	31%	12%	1.9%	0.3%	110%	213%
RE-062-00-IC-SBB	116%	74%	0%	166%	23%	43%	26%	4.2%	0.1%	118%	214%
RE-062-00-IC-SBC	126%	93%	180%	186%	16%	35%	27%	1.9%	0.0%	130%	286%
RE-077-50-IC-SBA	102%	111%	0%	124%	14%	12%	45%	2.8%	0.0%	99%	110%
RE-077-50-IC-SBB	88%	74%	180%	103%	5%	10%	44%	3.6%	0.0%	92%	111%
RE-077-50-IC-SBC	130%	111%	0%	124%	6%	2%	27%	1.1%	0.0%	85%	52%
RF-085-00-IC-SBA	102%	93%	180%	145%	7%	36%	26%	4.0%	0.0%	112%	220%
RF-085-00-IC-SBB	91%	93%	0%	124%	11%	45%	31%	1.3%	0.0%	114%	239%
RF-085-00-IC-SBC	67%	56%	0%	103%	3%	41%	22%	2.1%	0.0%	119%	239%
RF-090-00-IC-SBA	88%	74%	180%	83%	6%	14%	23%	0.8%	0.0%	107%	179%
RF-090-00-IC-SBB	77%	37%	0%	166%	3%	11%	29%	0.3%	0.0%	99%	191%
RF-090-00-IC-SBC	53%	37%	180%	83%	1%	28%	23%	0.0%	0.0%	110%	242%
RG-128-50-IC-SBA	77%	37%	0%	41%	1%	4%	29%	0.5%	0.0%	89%	44%
RG-128-50-IC-SBB	81%	56%	180%	103%	5%	6%	30%	0.0%	0.4%	95%	73%
RG-128-50-IC-SBC	102%	56%	0%	145%	4%	9%	24%	0.2%	0.0%	100%	131%
RG-140-00-IC-SBA	98%	93%	180%	124%	7%	32%	17%	3.4%	0.0%	102%	158%
RG-140-00-IC-SBB	130%	148%	180%	145%	11%	23%	22%	6.8%	0.4%	101%	129%
RG-140-00-IC-SBC	91%	74%	180%	124%	4%	20%	20%	2.3%	0.0%	95%	129%
RH-142-00-IC-SBA	105%	74%	0%	145%	4%	13%	27%	7.8%	0.0%	92%	185%
RH-142-00-IC-SBB	84%	56%	0%	145%	3%	7%	37%	6.6%	0.3%	92%	176%
RH-142-00-IC-SBC	56%	37%	0%	41%	8%	6%	36%	6.1%	0.0%	92%	107%
RH-143-00-IC-SBA	116%	130%	0%	103%	14%	9%	20%	1.2%	0.0%	90%	166%
RH-143-00-IC-SBB	116%	130%	0%	166%	14%	5%	11%	10.3%	0.3%	86%	66%
RH-143-00-IC-SBC	98%	74%	0%	103%	9%	4%	20%	3.7%	0.0%	84%	132%
RH-151-50-IC-SBA	109%	93%	180%	124%	6%	3%	28%	1.5%	0.0%	85%	59%
RH-151-50-IC-SBB	84%	93%	180%	83%	3%	4%	35%	5.3%	0.0%	86%	59%
RH-151-50-IC-SBC	137%	130%	180%	124%	8%	4%	20%	12.2%	0.0%	85%	58%
RI-166-00-SBA	74%	37%	0%	41%	1%	15%	34%	1.2%	0.0%	82%	97%
RI-166-00-SBB	63%	19%	0%	41%	0%	0%	67%	1.6%	0.0%	85%	33%
RI-166-00-SBC	81%	37%	180%	83%	1%	6%	28%	2.5%	0.0%	86%	139%
RI-169-50-IC-SBA	102%	74%	180%	103%	3%	7%	20%	2.4%	0.0%	90%	99%
RI-169-50-IC-SBB	95%	56%	0%	103%	1%	2%	44%	2.6%	0.0%	88%	27%
RI-169-50-IC-SBC	98%	19%	180%	83%	0%	6%	24%	2.9%	0.0%	85%	111%
RK-201-00-IC-SBA	112%	186%	180%	124%	24%	11%	20%	1.4%	0.0%	95%	109%
RK-201-00-IC-SBB	84%	93%	0%	83%	16%	9%	14%	0.7%	0.0%	85%	103%
RK-201-00-IC-SBC	88%	93%	180%	83%	21%	13%	25%	0.8%	0.0%	96%	63%
RM-285-00-IC-SBA	98%	130%	180%	83%	10%	18%	42%	2.4%	0.0%	100%	126%
RM-285-00-IC-SBB	109%	130%	180%	103%	12%	9%	34%	4.5%	0.0%	93%	92%
RM-285-00-IC-SBC	102%	93%	180%	103%	3%	11%	25%	0.3%	0.0%	94%	123%
TR-Ref-01-SBA	112%	111%	180%	103%	27%	16%	15%	3.1%	3.1%	112%	43%
TR-Ref-01-SBB	137%	111%	180%	207%	22%	29%	12%	4.0%	0.8%	114%	136%
TR-Ref-01-SBC	126%	93%	180%	228%	10%	65%	27%	1.7%	0.0%	136%	270%
TR-Ref-02-SBA	151%	148%	180%	124%	35%	8%	19%	11.8%	0.0%	103%	41%
TR-Ref-02-SBB	112%	148%	180%	103%	33%	11%	20%	7.5%	0.0%	103%	24%
TR-Ref-02-SBC	119%	148%	180%	166%	33%	24%	19%	4.9%	0.0%	113%	86%
CR-Ref-01-IC-SBA	112%	111%	180%	145%	28%	13%	26%	0.0%	0.0%	109%	116%
CR-Ref-01-IC-SBB	56%	37%	0%	124%	6%	28%	32%	0.0%	0.0%	120%	324%
CR-Ref-01-IC-SBC	70%	37%	180%	124%	8%	50%	33%	0.0%	0.0%	151%	328%
CR-Ref-02-IC-SBA	56%	74%	0%	62%	23%	6%	43%	0.0%	3.6%	82%	15%
CR-Ref-02-IC-SBB	63%	111%	0%	21%	25%	1%	29%	0.0%	12.7%	87%	41%
CR-Ref-02-IC-SBC	91%	130%	0%	41%	43%	3%	21%	0.7%	9.3%	94%	28%
RB-013+50-SBA	56%	74%	0%	62%	23%	6%	43%	0.0%	3.6%	83%	30%
RB-013+50-SBB	70%	56%	0%	21%	2%	1%	29%	1.8%	22.4%	81%	45%
RB-013+50-SBC	77%	37%	0%	0%	1%	0%	17%	3.5%	7.5%	90%	43%
RB-013-00-IC-SBA	112%	130%	180%	83%	15%	3%	18%	7.3%	0.0%	91%	78%
RB-013-00-IC-SBB	154%	148%	180%	83%	19%	3%	11%	3.6%	7.9%	95%	76%
RB-013-00-IC-SBC	123%	93%	0%	103%	5%	3%	21%	1.2%	0.0%	89%	78%
Composite Reference Mean	100%	100%	100%	100%	20%	15%	24%	3%	4%	100%	100%

Table 4-3a. EPA Multi-Metric Scoring for Grab Samples Compared to the Composite Reference: Reach and Locations

Location	Metric Score											Total
	Taxa Richness	# of Mayfly Taxa	# of Stonefly Taxa	# of Caddisfly Taxa	% Mayfly Comp	% Caddisfly Comp	% Dominant Taxon	% Isopods, Snails, Leeches	% Surface Dependent	HBI	Ratio of Filterers/Total	
RE-062-00-IC-SBA	6	6	6	6	0	6	6	6	6	6	6	60
RE-062-00-IC-SBB	6	4	0	6	4	6	4	6	6	6	6	54
RE-062-00-IC-SBC	6	6	6	6	4	6	4	6	6	6	6	62
RE-077-50-IC-SBA	6	6	0	6	0	4	0	6	6	6	6	46
RE-077-50-IC-SBB	6	4	6	6	0	4	0	6	6	6	6	50
RE-077-50-IC-SBC	6	6	0	6	0	2	4	6	6	4	2	42
RF-085-00-IC-SBA	6	6	6	6	0	6	4	6	6	6	6	58
RF-085-00-IC-SBB	6	6	0	6	0	6	2	6	6	6	6	50
RF-085-00-IC-SBC	4	2	0	6	0	6	4	6	6	6	6	46
RF-090-00-IC-SBA	6	4	6	6	0	4	4	6	6	6	6	54
RF-090-00-IC-SBB	4	0	0	6	0	4	4	6	6	6	6	42
RF-090-00-IC-SBC	2	0	6	6	0	6	4	6	6	6	6	48
RG-128-50-IC-SBA	4	0	0	2	0	4	4	6	6	6	0	32
RG-128-50-IC-SBB	6	2	6	6	0	4	4	6	6	6	4	50
RG-128-50-IC-SBC	6	2	0	6	0	4	4	6	6	6	6	46
RG-140-00-IC-SBA	6	6	6	6	0	6	6	6	6	6	6	60
RG-140-00-IC-SBB	6	6	6	6	0	6	4	4	6	6	6	56
RG-140-00-IC-SBC	6	4	6	6	0	4	4	6	6	6	6	54
RH-142-00-IC-SBA	6	4	0	6	0	4	4	4	6	6	6	46
RH-142-00-IC-SBB	6	2	0	6	0	4	2	4	6	6	6	42
RH-142-00-IC-SBC	2	0	0	2	0	4	2	4	6	6	6	32
RH-143-00-IC-SBA	6	6	0	6	0	4	4	6	6	6	6	50
RH-143-00-IC-SBB	6	6	0	6	0	4	6	4	6	6	4	48
RH-143-00-IC-SBC	6	4	0	6	0	4	6	6	6	4	6	48
RH-151-50-IC-SBA	6	6	6	6	0	2	4	6	6	4	2	48
RH-151-50-IC-SBB	6	6	6	6	0	4	2	6	6	6	2	50
RH-151-50-IC-SBC	6	6	6	6	0	4	4	4	6	6	2	50
RI-166-00-SBA	4	0	0	2	0	4	2	6	6	4	6	34
RI-166-00-SBB	4	0	0	2	0	0	0	6	6	4	0	22
RI-166-00-SBC	6	0	6	6	0	4	4	6	6	6	6	50
RI-169-50-IC-SBA	6	4	6	6	0	4	6	6	6	6	6	56
RI-169-50-IC-SBB	6	2	0	6	0	2	0	6	6	6	0	34
RI-169-50-IC-SBC	6	0	6	6	0	4	4	6	6	6	6	50
RK-201-00-IC-SBA	6	6	6	6	6	4	4	6	6	6	6	62
RK-201-00-IC-SBB	6	6	0	6	4	4	6	6	6	6	6	56
RK-201-00-IC-SBC	6	6	6	6	4	4	4	6	6	6	2	56
RM-285-00-IC-SBA	6	6	6	6	0	4	0	6	6	6	6	52
RM-285-00-IC-SBB	6	6	6	6	0	4	2	6	6	6	6	54
RM-285-00-IC-SBC	6	6	6	6	0	4	4	6	6	6	6	56
TR-Ref-01-SBA	6	6	6	6	6	4	6	6	6	6	0	58
TR-Ref-01-SBB	6	6	6	6	4	6	6	6	6	6	6	64
TR-Ref-01-SBC	6	6	6	6	0	6	4	6	6	6	6	58
TR-Ref-02-SBA	6	6	6	6	6	4	6	4	6	6	0	56
TR-Ref-02-SBB	6	6	6	6	6	4	4	4	6	6	0	54
TR-Ref-02-SBC	6	6	6	6	6	6	6	6	6	6	6	66
CR-Ref-01-IC-SBA	6	6	6	6	6	4	4	6	6	6	6	62
CR-Ref-01-IC-SBB	2	0	0	6	0	6	2	6	6	6	6	40
CR-Ref-01-IC-SBC	4	0	6	6	0	6	2	6	6	6	6	48
CR-Ref-02-IC-SBA	2	4	0	4	4	4	0	6	6	4	0	34
CR-Ref-02-IC-SBB	4	6	0	0	6	0	4	6	4	6	0	36
CR-Ref-02-IC-SBC	6	6	0	2	6	2	4	6	6	6	0	44
RB-013+50-SBA	2	4	0	4	4	4	0	6	6	4	0	34
RB-013+50-SBB	4	2	0	0	0	0	4	6	4	4	0	24
RB-013+50-SBC	4	0	0	0	0	0	6	6	6	6	0	28
RB-013-00-IC-SBA	6	6	6	6	4	4	6	4	6	6	4	58
RB-013-00-IC-SBB	6	6	6	6	4	2	6	6	6	6	4	58
RB-013-00-IC-SBC	6	6	0	6	0	2	4	6	6	6	4	46
Composite Reference Mean	6	6	6	6	4	4	4	6	6	6	6	60

Table 4-3a. EPA Multi-Metric Scoring for Grab Samples Compared to the Composite Reference: Reach and Locations

Location	Biological Condition Category					
	% of Reference (replicate)	% of Reference (location)	% of Reference (reach)	Biological Condition Category (replicate)	Biological Condition Category (location)	Biological Condition Category (reach)
RE-062-00-IC-SBA	100%			Non		
RE-062-00-IC-SBB	90%	98%		Non	Non	
RE-062-00-IC-SBC	103%			Non		
RE-077-50-IC-SBA	77%		87%	Slight		Non
RE-077-50-IC-SBB	83%	77%		Non	Slight	
RE-077-50-IC-SBC	70%			Slight		
RF-085-00-IC-SBA	97%			Non		
RF-085-00-IC-SBB	83%	86%		Non	Non	
RF-085-00-IC-SBC	77%			Slight		
RF-090-00-IC-SBA	90%		83%	Non		Non to slight
RF-090-00-IC-SBB	70%	80%		Slight	Non to slight	
RF-090-00-IC-SBC	80%			Non to slight		
RG-128-50-IC-SBA	53%			Slight to moderate		
RG-128-50-IC-SBB	83%	71%		Non	Slight	
RG-128-50-IC-SBC	77%			Slight		
RG-140-00-IC-SBA	100%		83%	Non		Non to slight
RG-140-00-IC-SBB	93%	94%		Non	Non	
RG-140-00-IC-SBC	90%			Non		
RH-142-00-IC-SBA	77%			Slight		
RH-142-00-IC-SBB	70%	67%		Slight	Slight	
RH-142-00-IC-SBC	53%			Slight to moderate		
RH-143-00-IC-SBA	83%			Non		
RH-143-00-IC-SBB	80%	81%	77%	Non to slight	Non to slight	Slight
RH-143-00-IC-SBC	80%			Non to slight		
RH-151-50-IC-SBA	80%			Non to slight		
RH-151-50-IC-SBB	83%	82%		Non	Non to slight	
RH-151-50-IC-SBC	83%			Non		
RI-166-00-SBA	57%			Slight		
RI-166-00-SBB	37%	59%		Moderate	Slight	
RI-166-00-SBC	83%			Non		
RI-169-50-IC-SBA	93%		68%	Non		Slight
RI-169-50-IC-SBB	57%	78%		Slight	Slight	
RI-169-50-IC-SBC	83%			Non		
RK-201-00-IC-SBA	103%			Non		
RK-201-00-IC-SBB	93%	97%	97%	Non	Non	Non
RK-201-00-IC-SBC	93%			Non		
RM-285-00-IC-SBA	87%			Non		
RM-285-00-IC-SBB	90%	90%	90%	Non	Non	Non
RM-285-00-IC-SBC	93%			Non		
TR-Ref-01-SBA	97%			Non		
TR-Ref-01-SBB	107%	100%		Non	Non	
TR-Ref-01-SBC	97%		99%	Non		Non
TR-Ref-02-SBA	93%			Non		
TR-Ref-02-SBB	90%	98%		Non	Non	
TR-Ref-02-SBC	110%			Non		
CR-Ref-01-IC-SBA	103%			Non		
CR-Ref-01-IC-SBB	67%	83%		Slight	Non	
CR-Ref-01-IC-SBC	80%			Non to slight		
CR-Ref-02-IC-SBA	57%		73%	Slight		Slight
CR-Ref-02-IC-SBB	60%	63%		Slight	Slight	
CR-Ref-02-IC-SBC	73%			Slight		
RB-013+50-SBA	57%			Slight		
RB-013+50-SBB	40%	48%		Moderate	Moderate	
RB-013+50-SBC	47%			Moderate		
RB-013-00-IC-SBA	97%		69%	Non		Slight
RB-013-00-IC-SBB	97%	90%		Non	Non	
RB-013-00-IC-SBC	77%			Slight		
Composite Reference Mean						

HBI: Hilsenhoff Biotic Index
EPA: United States Environmental Protection Agency

Table 4-3b. Summary of EPA Biological Condition Scores for Grab Samples: Reach and Locations

Location	Biological Condition Category Based on EPA Multi-Metric Scoring Compared to Composite Reference (Grabs) (a)	
	Locations	Reaches
Composite Reference	Non Impaired	Non Impaired
TR-Ref-01	Non Impaired	Non Impaired
TR-Ref-02	Non Impaired	
CR-Ref-01	Non Impaired	
CR-Ref-02	Slightly Impaired	Slightly Impaired
RB-013+50	Moderately Impaired	
RB-013-00	Non Impaired	Slightly Impaired
RE-062-00*	Non Impaired	
RE-077-50	Slightly Impaired	
RF-085-00	Non Impaired	Non- to slightly Impaired
RF-090-00	Non- to slightly Impaired	
RG-128-50	Slightly Impaired	Non- to slightly Impaired
RG-140-00	Non Impaired	
RH-142-00	Slightly Impaired	Slightly Impaired
RH-143-00	Non- to slightly Impaired	
RH-151-50*	Non- to slightly Impaired	
RI-166-00	Slightly Impaired	Slightly Impaired
RI-169-50	Slightly Impaired	
RK-201-00	Non Impaired	Non Impaired
RM-285-00	Non Impaired	Non Impaired

- (a) Note that impairment may be related to habitat quality. Figure 5-2 overlays benthic community scoring results and habitat scoring results so these relationships can be considered. Statistical testing was also conducted and results showed that there are no significant differences between Reaches E through M and the Composite Reference, and there are no statistically significant differences between Locations and the Composite Reference.

* Sediment Management Area
EPA: United States Environmental Protection Agency

Table 4-4a. EPA Multi-Metric Scoring for Hester Dendy Samples Compared to the Composite Reference: Reach and Locations

Location	Biological Metrics										
	Taxa Richness	# of Mayfly Taxa	# of Stonefly Taxa	# of Caddisfly Taxa	% Mayfly Comp	% Caddisfly Comp	% Dominant Taxon	% Isopods, Snails, Leeches	% Surface Dependent	HBI	Ratio of Filteres/Total
RE-061-00-HD1	32	5	2	7	2.6	10.6	33.5	0.2	0	5.7	0.19
RE-061-00-HD2	31	3	2	5	1.8	9.0	29.4	0.2	0	6.0	0.40
RE-061-00-HD3	22	1	1	2	1.1	9.5	22.1	3.2	0	6.0	0.24
RE-061-00-HD4	29	2	2	5	0.8	13.7	22.7	0.8	0	6.3	0.29
RE-061-00-HD5	29	3	1	4	2.4	10.7	27.4	1.2	0	6.0	0.18
RE-062-00-HD1	35	5	3	6	4.0	9.4	26.5	0.3	0.14	4.4	0.35
RE-062-00-HD2	41	6	3	9	8.4	14.3	32.9	0.1	0.13	5.2	0.47
RE-062-00-HD3	37	8	2	7	6.0	4.7	25.0	0.9	0	4.6	0.30
RE-062-00-HD4	37	5	2	6	4.2	5.9	21.3	0.5	0	5.1	0.29
RE-062-00-HD5	38	5	3	7	2.0	6.2	33.1	0.4	0	6.1	0.22
RE-073-00-HD1	28	1	1	3	0.3	1.1	50.7	0.3	0	6.6	0.12
RE-073-00-HD2	26	1	1	2	0.2	1.3	42.2	0.2	0	6.8	0.16
RE-073-00-HD5	30	4	1	4	1.0	3.1	37.8	0.2	0	6.3	0.10
RF-082-00-HD1	25	1	1	3	0.3	0.9	48.1	2.6	0	6.8	0.05
RF-082-00-HD2	23	1	2	0	0.6	0.0	23.9	0.0	0	6.4	0.16
RF-082-00-HD3	16	0	2	1	0.0	1.4	21.7	0.0	0	5.9	0.32
RF-082-00-HD4	19	1	1	3	0.3	0.9	33.6	0.3	0	6.1	0.04
RF-082-00-HD5	27	4	1	6	3.3	14.7	28.8	0.2	0	5.3	0.46
RG-136-00-HD1	32	5	1	4	3.1	3.6	27.6	1.6	0	5.2	0.32
RG-136-00-HD2	29	4	2	5	4.7	5.7	24.4	1.4	0	5.0	0.33
RG-136-00-HD3	32	6	2	7	4.2	6.7	29.7	0.5	0	4.9	0.33
RG-136-00-HD4	28	4	2	5	2.2	1.8	21.5	5.2	0	5.7	0.21
RG-136-00-HD5	25	4	1	4	2.3	2.7	24.3	3.8	0	5.5	0.15
RG-137-50-HD1	25	3	2	4	2.6	6.2	39.7	0.2	0	6.5	0.23
RG-137-50-HD2	28	3	2	5	1.1	1.2	33.2	0.0	0	6.4	0.34
RG-137-50-HD3	22	4	2	2	2.6	0.5	42.6	0.1	0	6.6	0.32
RG-137-50-HD4	26	5	2	5	1.4	2.6	38.6	0.3	0	6.5	0.29
RG-137-50-HD5	28	6	2	7	4.8	1.5	46.9	1.0	0	6.6	0.20
RH-143-00-HD1	24	5	2	7	1.7	2.9	36.0	0.0	0	5.8	0.40
RH-143-00-HD2	28	5	2	7	2.0	4.7	51.9	0.3	0	6.6	0.31
RH-143-00-HD3	39	6	1	8	2.9	4.2	42.6	0.2	0	6.4	0.25
RH-144-50-HD1	21	4	2	2	3.1	0.9	58.0	0.0	0	6.7	0.15
RH-144-50-HD2	18	6	1	3	3.4	3.1	37.5	0.0	0	6.2	0.35
RH-144-50-HD3	29	2	2	6	2.1	0.6	36.3	0.1	0	6.6	0.33
RH-144-50-HD4	25	4	2	3	2.4	0.8	29.2	0.0	0	6.0	0.28
RH-144-50-HD5	25	5	2	3	2.8	2.1	30.6	0.2	0	5.8	0.24
RH-150-00-HD1	17	2	1	1	0.5	0.2	57.5	0.0	0	7.2	0.12
RH-150-00-HD2	22	4	2	0	1.3	0.0	55.6	0.2	0	7.2	0.15
RH-150-00-HD3	27	4	2	3	1.6	0.4	48.0	0.1	0	6.8	0.15
RH-150-00-HD4	19	3	1	2	1.5	0.2	47.1	0.2	0	6.8	0.27
RH-150-00-HD5	25	3	1	4	2.2	2.1	51.3	0.5	0	6.8	0.17
RI-164-00-HD1	22	4	1	5	1.9	1.2	61.2	0.0	0	7.1	0.13
RI-164-00-HD2	23	3	2	4	1.4	1.8	63.9	0.0	0	7.2	0.11
RI-164-00-HD3	31	8	1	8	1.9	3.7	56.4	0.0	0	6.8	0.17
RI-164-00-HD4	26	5	1	6	5.2	11.0	49.0	0.0	0	6.6	0.23
RI-164-00-HD5	23	2	1	5	2.9	6.3	29.1	0.0	0	6.0	0.42
RI-164-50-HD1	24	2	0	0	0.3	0.0	56.2	0.6	0	7.3	0.06
RI-164-50-HD2	21	2	0	0	0.3	0.0	65.7	2.2	0	7.6	0.06
RI-164-50-HD3	27	1	1	1	0.1	0.1	59.0	1.2	0.14	7.0	0.06
RI-164-50-HD4	21	1	1	1	0.1	0.1	51.3	0.6	0	6.9	0.19
RI-164-50-HD5	17	0	0	0	0.0	0.0	59.1	1.3	0	7.3	0.05
RI-168-50-HD1	26	2	1	2	0.6	3.3	26.9	2.7	0.19	6.5	0.24
RI-168-50-HD2	25	2	1	3	0.7	2.8	47.0	1.7	0	7.0	0.19
RI-168-50-HD3	30	2	1	4	0.3	2.8	19.4	5.5	0	6.6	0.22
RI-168-50-HD4	24	2	1	6	0.7	10.8	27.2	3.5	0	6.5	0.23
RI-168-50-HD5	25	2	0	4	0.4	5.8	40.6	3.9	0	6.8	0.21
RK-201-00-HD1	20	2	1	5	0.6	20.4	17.9	0.0	0	5.0	0.32
RK-201-00-HD2	15	2	1	3	2.8	1.9	40.7	0.0	0	6.3	0.16
RK-201-00-HD3	19	4	1	2	2.2	3.5	24.0	0.0	0	5.4	0.16
RK-201-00-HD4	24	5	1	3	7.6	2.5	27.9	0.0	0	5.8	0.09
RK-201-00-HD5	20	4	1	3	3.1	7.6	32.5	0.0	0	5.9	0.20
RM-285-00-HD1	16	3	1	4	1.9	23.9	28.0	0.0	0	5.8	0.52
RM-285-00-HD2	18	3	1	4	1.0	22.8	21.9	0.0	0	5.4	0.38
RM-285-00-HD3	20	2	2	4	1.4	12.0	27.2	0.0	0	4.7	0.32
RM-285-00-HD4	20	4	1	5	0.9	6.4	29.1	0.2	0	5.6	0.20
RM-285-00-HD5	24	3	2	3	1.2	5.8	25.5	0.0	0	5.6	0.24
TR-REF-01-HD1	28	3	1	4	11.4	5.4	26.1	1.1	0	4.6	0.13
TR-REF-01-HD2	23	2	1	6	15.6	11.7	35.1	1.5	0	4.1	0.08
TR-REF-01-HD3	26	3	2	7	8.1	13.0	38.6	0.3	0	3.7	0.14
TR-REF-01-HD4	25	3	1	4	12.4	8.8	24.1	2.9	0	4.1	0.15
TR-REF-01-HD5	25	3	1	4	22.5	15.6	15.0	0.6	0	4.6	0.18
TR-REF-02-HD1	27	4	2	5	33.2	10.3	29.4	1.9	0	4.0	0.11
TR-REF-02-HD2	34	5	2	6	30.1	21.1	23.8	0.6	0	4.3	0.23
TR-REF-02-HD3	23	2	1	6	39.6	19.6	38.6	0.5	0	4.1	0.22
TR-REF-02-HD4	23	3	1	6	43.0	18.3	37.3	0.4	0	4.3	0.20
TR-REF-02-HD5	17	2	1	4	24.4	15.6	20.0	0.0	0	4.8	0.26
CR-REF-01-HD1	32	7	2	6	5.3	5.0	56.1	0.0	0	5.7	0.61
CR-REF-01-HD2	33	8	2	9	4.6	8.8	74.2	0.0	0	5.6	0.83
CR-REF-01-HD3	23	4	3	2	10.6	2.7	28.2	0.8	0	7.0	0.18
CR-REF-01-HD4	21	3	1	4	3.0	2.5	56.6	0.5	0	5.7	0.59
CR-REF-01-HD5	29	8	3	2	6.1	2.2	55.3	0.5	0	5.7	0.58
CR-REF-02-HD1	29	8	2	4	19.2	2.7	24.2	0.5	0	5.9	0.20
CR-REF-02-HD2	30	6	3	2	6.8	0.7	21.6	0.0	0	6.2	0.23
CR-REF-02-HD3	33	8	2	7	2.8	3.6	28.7	0.8	0	6.4	0.38
CR-REF-02-HD4	35	6	3	6	6.6	2.5	21.8	1.1	0	6.8	0.14
CR-REF-02-HD5	35	5	1	5	11.8	2.4	18.9	4.3	0	6.3	0.19
RA-003-50-HD1	30	4	2	3	6.0	2.2	31.5	0.7	0	6.0	0.35
RA-003-50-HD2	26	2	1	2	2.8	2.8	27.5	0.9	0	7.6	0.06
RA-003-50-HD3	32	5	3	4	3.8	2.8	12.6	0.3	0	5.9	0.07
RA-003-50-HD4	27	3	2	1	2.7	0.3	23.1	0.3	0	5.7	0.23
RA-003-50-HD5	27	4	2	2	2.0	1.1	39.4	0.3	0	6.4	0.12
RB-012-50-HD1	26	2	0	3	0.8	1.1	22.5	4.5	0.27	6.0	0.18
RB-012-50-HD2	24	3	0	1	1.6	0.4	34.8	1.2	0	6.7	0.21
RB-012-50-HD3	24	3	0	3	0.8	0.8	41.4	2.5	0	6.4	0.28
RB-012-50-HD4	21	2	0	1	0.5	0.5	26.4	2.3	0	6.1	0.12
RB-012-50-HD5	21	2	1	4	0.8	1.7	40.2	1.1	0	5.7	0.17
Composite Reference Mean	27	4	2	4	11.3	6.2	32.4	1.1	0.01	5.5	0.2

Table 4-4a. EPA Multi-Metric Scoring for Hester Dendy Samples Compared to the Composite Reference: Reach and Locations

Location	Biological Condition Score										
	Taxa Richness	# of Mayfly Taxa	# of Stonefly Taxa	# of Caddisfly Taxa	% Mayfly Comp	% Caddisfly Comp	% Dominant Taxon	% Isopods, Snails, Leeches	% Surface Dependent	HBI	Ratio of Filteres/Total
RE-061-00-HD1	119%	122%	130%	171%	3%	11%	34%	0%	0%	97%	75%
RE-061-00-HD2	115%	73%	130%	122%	2%	9%	29%	0%	0%	92%	161%
RE-061-00-HD3	82%	24%	65%	49%	1%	9%	22%	3%	0%	92%	98%
RE-061-00-HD4	108%	49%	130%	122%	1%	14%	23%	1%	0%	88%	118%
RE-061-00-HD5	108%	73%	65%	98%	2%	11%	27%	1%	0%	93%	73%
RE-062-00-HD1	130%	122%	196%	146%	4%	9%	26%	0%	0.1%	125%	141%
RE-062-00-HD2	152%	146%	196%	220%	8%	14%	33%	0%	0.1%	106%	192%
RE-062-00-HD3	137%	195%	130%	171%	6%	5%	25%	1%	0%	119%	123%
RE-062-00-HD4	137%	122%	130%	146%	4%	6%	21%	0%	0%	109%	116%
RE-062-00-HD5	141%	122%	196%	171%	2%	6%	33%	0%	0%	91%	90%
RE-073-00-HD1	104%	24%	65%	73%	0%	1%	51%	0%	0%	84%	50%
RE-073-00-HD2	96%	24%	65%	49%	0%	1%	42%	0%	0%	81%	63%
RE-073-00-HD5	111%	98%	65%	98%	1%	3%	38%	0%	0%	88%	39%
RF-082-00-HD1	93%	24%	65%	73%	0%	1%	48%	3%	0%	81%	20%
RF-082-00-HD2	85%	24%	130%	0%	1%	0%	24%	0%	0%	87%	65%
RF-082-00-HD3	59%	0%	130%	24%	0%	1%	22%	0%	0%	94%	130%
RF-082-00-HD4	70%	24%	65%	73%	0%	1%	34%	0%	0%	92%	18%
RF-082-00-HD5	100%	98%	65%	146%	3%	15%	29%	0%	0%	105%	187%
RG-136-00-HD1	119%	122%	65%	98%	3%	4%	28%	2%	0%	106%	129%
RG-136-00-HD2	108%	98%	130%	122%	5%	6%	24%	1%	0%	110%	135%
RG-136-00-HD3	119%	146%	130%	171%	4%	7%	30%	1%	0%	113%	132%
RG-136-00-HD4	104%	98%	130%	122%	2%	2%	22%	5%	0%	97%	86%
RG-136-00-HD5	93%	98%	65%	98%	2%	3%	24%	4%	0%	100%	63%
RG-137-50-HD1	93%	73%	130%	98%	3%	6%	40%	0%	0%	85%	95%
RG-137-50-HD2	104%	73%	130%	122%	1%	1%	33%	0%	0%	86%	138%
RG-137-50-HD3	82%	98%	130%	49%	3%	0%	43%	0%	0%	84%	128%
RG-137-50-HD4	96%	122%	130%	122%	1%	3%	39%	0%	0%	86%	118%
RG-137-50-HD5	104%	146%	130%	171%	5%	1%	47%	1%	0%	84%	80%
RH-143-00-HD1	89%	122%	130%	171%	2%	3%	36%	0%	0%	96%	161%
RH-143-00-HD2	104%	122%	130%	171%	2%	5%	52%	0%	0%	83%	126%
RH-143-00-HD3	145%	146%	65%	195%	3%	4%	43%	0%	0%	87%	99%
RH-144-50-HD1	78%	98%	130%	49%	3%	1%	58%	0%	0%	83%	61%
RH-144-50-HD2	67%	146%	65%	73%	3%	3%	37%	0%	0%	89%	142%
RH-144-50-HD3	108%	49%	130%	146%	2%	1%	36%	0%	0%	84%	135%
RH-144-50-HD4	93%	98%	130%	73%	2%	1%	29%	0%	0%	92%	114%
RH-144-50-HD5	93%	122%	130%	73%	3%	2%	31%	0%	0%	95%	97%
RH-150-00-HD1	63%	49%	65%	24%	0%	0%	58%	0%	0%	77%	47%
RH-150-00-HD2	82%	98%	130%	0%	1%	0%	56%	0%	0%	77%	60%
RH-150-00-HD3	100%	98%	130%	73%	2%	0%	48%	0%	0%	81%	61%
RH-150-00-HD4	70%	73%	65%	49%	1%	0%	47%	0%	0%	82%	108%
RH-150-00-HD5	93%	73%	65%	98%	2%	2%	51%	0%	0%	82%	68%
RI-164-00-HD1	82%	98%	65%	122%	2%	1%	61%	0%	0%	79%	51%
RI-164-00-HD2	85%	73%	130%	98%	1%	2%	64%	0%	0%	77%	44%
RI-164-00-HD3	115%	195%	65%	195%	2%	4%	56%	0%	0%	81%	68%
RI-164-00-HD4	96%	122%	65%	146%	5%	11%	49%	0%	0%	84%	94%
RI-164-00-HD5	85%	49%	65%	122%	3%	6%	29%	0%	0%	93%	171%
RI-164-50-HD1	89%	49%	0%	0%	0%	0%	56%	1%	0%	76%	26%
RI-164-50-HD2	78%	49%	0%	0%	0%	0%	66%	2%	0%	73%	23%
RI-164-50-HD3	100%	24%	65%	24%	0%	0%	59%	1%	0.1%	79%	25%
RI-164-50-HD4	78%	24%	65%	24%	0%	0%	51%	1%	0%	80%	76%
RI-164-50-HD5	63%	0%	0%	0%	0%	0%	59%	1%	0%	76%	20%
RI-168-50-HD1	96%	49%	65%	49%	1%	3%	27%	3%	0.2%	85%	96%
RI-168-50-HD2	93%	49%	65%	73%	1%	3%	47%	2%	0%	80%	76%
RI-168-50-HD3	111%	49%	65%	98%	0%	3%	19%	6%	0%	84%	88%
RI-168-50-HD4	89%	49%	65%	146%	1%	11%	27%	4%	0%	86%	93%
RI-168-50-HD5	93%	49%	0%	98%	0%	6%	41%	4%	0%	82%	84%
RK-201-00-HD1	74%	49%	65%	122%	1%	20%	18%	0%	0%	111%	128%
RK-201-00-HD2	56%	49%	65%	73%	3%	2%	41%	0%	0%	88%	64%
RK-201-00-HD3	70%	98%	65%	49%	2%	4%	24%	0%	0%	103%	63%
RK-201-00-HD4	89%	122%	65%	73%	8%	3%	28%	0%	0%	96%	37%
RK-201-00-HD5	74%	98%	65%	73%	3%	8%	33%	0%	0%	94%	81%
RM-285-00-HD1	59%	73%	65%	98%	2%	24%	28%	0%	0%	96%	210%
RM-285-00-HD2	67%	73%	65%	98%	1%	23%	22%	0%	0%	103%	152%
RM-285-00-HD3	74%	49%	130%	98%	1%	12%	27%	0%	0%	119%	131%
RM-285-00-HD4	74%	98%	65%	122%	1%	6%	29%	0%	0%	100%	79%
RM-285-00-HD5	89%	73%	130%	73%	1%	6%	25%	0%	0%	100%	97%
TR-REF-01-HD1	104%	73%	65%	98%	11%	5%	26%	1%	0%	120%	51%
TR-REF-01-HD2	85%	49%	65%	146%	16%	12%	35%	1%	0%	136%	34%
TR-REF-01-HD3	96%	73%	130%	171%	8%	13%	39%	0%	0%	148%	57%
TR-REF-01-HD4	93%	73%	65%	98%	12%	9%	24%	3%	0%	136%	62%
TR-REF-01-HD5	93%	73%	65%	98%	23%	16%	15%	1%	0%	120%	73%
TR-REF-02-HD1	100%	98%	130%	122%	33%	10%	29%	2%	0%	139%	45%
TR-REF-02-HD2	126%	122%	130%	146%	30%	21%	24%	1%	0%	128%	95%
TR-REF-02-HD3	85%	49%	65%	146%	40%	20%	39%	0%	0%	136%	87%
TR-REF-02-HD4	85%	73%	65%	146%	43%	18%	37%	0%	0%	129%	83%
TR-REF-02-HD5	63%	49%	65%	98%	24%	16%	20%	0%	0%	115%	103%
CR-REF-01-HD1	119%	171%	130%	146%	5%	5%	56%	0%	0%	98%	246%
CR-REF-01-HD2	122%	195%	130%	220%	5%	9%	74%	0%	0%	100%	334%
CR-REF-01-HD3	85%	98%	196%	49%	11%	3%	28%	1%	0%	79%	75%
CR-REF-01-HD4	78%	73%	65%	98%	3%	3%	57%	1%	0%	97%	237%
CR-REF-01-HD5	108%	195%	196%	49%	6%	2%	55%	0%	0%	97%	235%
CR-REF-02-HD1	108%	195%	130%	98%	19%	3%	24%	1%	0%	94%	80%
CR-REF-02-HD2	111%	146%	196%	49%	7%	1%	22%	0%	0%	90%	93%
CR-REF-02-HD3	122%	195%	130%	171%	3%	4%	29%	1%	0%	87%	153%
CR-REF-02-HD4	130%	146%	196%	146%	7%	2%	22%	1%	0%	81%	55%
CR-REF-02-HD5	130%	122%	65%	122%	12%	2%	19%	4%	0%	87%	75%
RA-003-50-HD1	111%	98%	130%	73%	6%	2%	31%	1%	0%	93%	141%
RA-003-50-HD2	96%	49%	65%	49%	3%	3%	28%	1%	0%	73%	26%
RA-003-50-HD3	119%	122%	196%	98%	4%	3%	13%	0%	0%	94%	30%
RA-003-50-HD4	100%	73%	130%	24%	3%	0%	23%	0%	0%	98%	93%
RA-003-50-HD5	100%	98%	130%	49%	2%	1%	39%	0%	0%	87%	50%
RB-012-50-HD1	96%	49%	0%	73%	1%	1%	22%	5%	0.3%	92%	72%
RB-012-50-HD2	89%	73%	0%	24%	2%	0%	35%	1%	0%	82%	85%
RB-012-50-HD3	89%	73%	0%	73%	1%	1%	41%	3%	0%	87%	115%
RB-012-50-HD4	78%	49%	0%	24%	1%	1%	26%	2%	0%	92%	49%
RB-012-50-HD5	78%	49%	65%	98%	1%	2%	40%	1%	0%	97%	68%
Composite Reference Mean	100%	100%	100%	100%	11%	6%	32%	1%	0%	100%	100%

Table 4-4a. EPA Multi-Metric Scoring for Hester Dendy Samples Compared to the Composite Reference: Reach and Locations

Location	Metric Score											
	Taxa Richness	# of Mayfly Taxa	# of Stonefly Taxa	# of Caddisfly Taxa	% Mayfly Comp	% Caddisfly Comp	% Dominant Taxon	% Isopods, Snails, Leeches	% Surface Dependent	HBI	Ratio of Filteres/Total	Total
RE-061-00-HD1	6	6	6	6	0	4	2	6	6	6	4	52
RE-061-00-HD2	6	4	6	6	0	4	4	6	6	6	6	54
RE-061-00-HD3	6	0	4	2	0	4	4	6	6	6	6	44
RE-061-00-HD4	6	2	6	6	0	4	4	6	6	6	6	52
RE-061-00-HD5	6	4	4	6	0	4	4	6	6	6	4	50
RE-062-00-HD1	6	6	6	6	0	4	4	6	6	6	6	56
RE-062-00-HD2	6	6	6	6	0	4	2	6	6	6	6	54
RE-062-00-HD3	6	6	6	6	0	4	4	6	6	6	6	56
RE-062-00-HD4	6	6	6	6	0	4	4	6	6	6	6	56
RE-062-00-HD5	6	6	6	6	0	4	2	6	6	6	6	54
RE-073-00-HD1	6	0	4	4	0	2	0	6	6	4	2	34
RE-073-00-HD2	6	0	4	2	0	2	0	6	6	4	2	32
RE-073-00-HD5	6	6	4	6	0	4	2	6	6	6	0	46
RF-082-00-HD1	6	0	4	4	0	0	0	6	6	4	0	30
RF-082-00-HD2	6	0	6	0	0	0	4	6	6	6	4	38
RF-082-00-HD3	2	0	6	0	0	2	4	6	6	6	6	38
RF-082-00-HD4	4	0	4	4	0	0	2	6	6	6	0	32
RF-082-00-HD5	6	6	4	6	0	4	4	6	6	6	6	54
RG-136-00-HD1	6	6	4	6	0	4	4	6	6	6	6	54
RG-136-00-HD2	6	6	6	6	0	4	4	6	6	6	6	56
RG-136-00-HD3	6	6	6	6	0	4	4	6	6	6	6	56
RG-136-00-HD4	6	6	6	6	0	2	4	6	6	6	6	54
RG-136-00-HD5	6	6	4	6	0	2	4	6	6	6	2	48
RG-137-50-HD1	6	4	6	6	0	4	2	6	6	6	6	52
RG-137-50-HD2	6	4	6	6	0	2	2	6	6	6	6	50
RG-137-50-HD3	6	6	6	2	0	0	0	6	6	4	6	42
RG-137-50-HD4	6	6	6	6	0	2	2	6	6	6	6	52
RG-137-50-HD5	6	6	6	6	0	2	0	6	6	4	6	48
RH-143-00-HD1	6	6	6	6	0	2	2	6	6	6	6	52
RH-143-00-HD2	6	6	6	6	0	4	0	6	6	4	6	50
RH-143-00-HD3	6	6	4	6	0	4	0	6	6	6	6	50
RH-144-50-HD1	4	6	6	2	0	0	0	6	6	4	2	36
RH-144-50-HD2	4	6	4	4	0	4	2	6	6	6	6	48
RH-144-50-HD3	6	2	6	6	0	0	2	6	6	4	6	44
RH-144-50-HD4	6	6	6	4	0	0	4	6	6	6	6	50
RH-144-50-HD5	6	6	6	4	0	2	2	6	6	6	6	50
RH-150-00-HD1	4	2	4	0	0	0	0	6	6	4	0	26
RH-150-00-HD2	6	6	6	0	0	0	0	6	6	4	2	36
RH-150-00-HD3	6	6	6	4	0	0	0	6	6	4	2	40
RH-150-00-HD4	4	4	4	2	0	0	0	6	6	4	6	36
RH-150-00-HD5	6	4	4	6	0	2	0	6	6	4	4	42
RI-164-00-HD1	6	6	4	6	0	2	0	6	6	4	2	42
RI-164-00-HD2	6	4	6	6	0	2	0	6	6	4	0	40
RI-164-00-HD3	6	6	4	6	0	4	0	6	6	4	4	46
RI-164-00-HD4	6	6	4	6	0	4	0	6	6	4	6	48
RI-164-00-HD5	6	2	4	6	0	4	4	6	6	6	6	50
RI-164-50-HD1	6	2	0	0	0	0	0	6	6	4	0	24
RI-164-50-HD2	4	2	0	0	0	0	0	6	6	4	0	22
RI-164-50-HD3	6	0	4	0	0	0	0	6	6	4	0	26
RI-164-50-HD4	4	0	4	0	0	0	0	6	6	4	4	28
RI-164-50-HD5	4	0	0	0	0	0	0	6	6	4	0	20
RI-168-50-HD1	6	2	4	2	0	4	4	6	6	4	6	44
RI-168-50-HD2	6	2	4	4	0	2	0	6	6	4	4	38
RI-168-50-HD3	6	2	4	6	0	2	6	6	6	4	6	48
RI-168-50-HD4	6	2	4	6	0	4	4	6	6	6	6	50
RI-168-50-HD5	6	2	0	6	0	4	0	6	6	4	6	40
RK-201-00-HD1	4	2	4	6	0	4	6	6	6	6	6	50
RK-201-00-HD2	2	2	4	4	0	2	0	6	6	6	2	34
RK-201-00-HD3	4	6	4	2	0	4	4	6	6	6	2	44
RK-201-00-HD4	6	6	4	4	0	2	4	6	6	6	0	44
RK-201-00-HD5	4	6	4	4	0	4	2	6	6	6	6	48
RM-285-00-HD1	2	4	4	6	0	6	4	6	6	6	6	50
RM-285-00-HD2	4	4	4	6	0	6	4	6	6	6	6	52
RM-285-00-HD3	4	2	6	6	0	4	4	6	6	6	6	50
RM-285-00-HD4	4	6	4	6	0	4	4	6	6	6	4	50
RM-285-00-HD5	6	4	6	4	0	4	4	6	6	6	6	52
TR-REF-01-HD1	6	4	4	6	0	4	4	6	6	6	2	48
TR-REF-01-HD2	6	2	4	6	4	4	2	6	6	6	0	46
TR-REF-01-HD3	6	4	6	6	0	4	2	6	6	6	2	48
TR-REF-01-HD4	6	4	4	6	0	4	4	6	6	6	2	48
TR-REF-01-HD5	6	4	4	6	4	4	6	6	6	6	4	56
TR-REF-02-HD1	6	6	6	6	6	4	4	6	6	6	0	56
TR-REF-02-HD2	6	6	6	6	6	4	4	6	6	6	6	62
TR-REF-02-HD3	6	2	4	6	6	4	2	6	6	6	6	54
TR-REF-02-HD4	6	4	4	6	6	4	2	6	6	6	6	56
TR-REF-02-HD5	4	2	4	6	6	4	4	6	6	6	6	54
CR-REF-01-HD1	6	6	6	6	0	4	0	6	6	6	6	52
CR-REF-01-HD2	6	6	6	6	0	4	0	6	6	6	6	52
CR-REF-01-HD3	6	6	6	2	0	2	4	6	6	4	4	46
CR-REF-01-HD4	4	4	4	6	0	2	0	6	6	6	6	44
CR-REF-01-HD5	6	6	6	2	0	2	0	6	6	6	6	46
CR-REF-02-HD1	6	6	6	6	4	2	4	6	6	6	4	56
CR-REF-02-HD2	6	6	6	2	0	0	4	6	6	6	6	48
CR-REF-02-HD3	6	6	6	6	0	4	4	6	6	6	6	56
CR-REF-02-HD4	6	6	6	6	0	2	4	6	6	4	2	48
CR-REF-02-HD5	6	6	4	6	0	2	6	6	6	6	4	52
RA-003-50-HD1	6	6	6	4	0	2	2	6	6	6	6	50
RA-003-50-HD2	6	2	4	2	0	2	4	6	6	4	0	36
RA-003-50-HD3	6	6	6	6	0	2	6	6	6	6	0	50
RA-003-50-HD4	6	4	6	0	0	0	4	6	6	6	6	44
RA-003-50-HD5	6	6	6	2	0	2	2	6	6	6	2	44
RB-012-50-HD1	6	2	0	4	0	2	4	6	6	6	4	40
RB-012-50-HD2	6	4	0	0	0	0	2	6	6	4	6	34
RB-012-50-HD3	6	4	0	4	0	0	0	6	6	6	6	38
RB-012-50-HD4	4	2	0	0	0	0	4	6	6	6	0	28
RB-012-50-HD5	4	2	4	6	0	2	0	6	6	6	4	40
Composite Reference Mean	6	6	6	6	0	4	2	6	6	6	6	54

Table 4-4a. EPA Multi-Metric Scoring for Hester Dendy Samples Compared to the Composite Reference: Reach and Locations

Location	Biological Condition Category					
	% of Reference	% of Reference (location)	% of Reference (reach)	Biological Condition Category (replicate)	Biological Condition Category (location)	Biological Condition Category (reach)
RE-061-00-HD1	96%			Non		
RE-061-00-HD2	100%			Non		
RE-061-00-HD3	81%	93%		Non to slight	Non	
RE-061-00-HD4	96%			Non		
RE-061-00-HD5	93%			Non		
RE-062-00-HD1	104%		91%	Non		Non
RE-062-00-HD2	100%			Non		
RE-062-00-HD3	104%	102%		Non	Non	
RE-062-00-HD4	104%			Non		
RE-062-00-HD5	100%			Non		
RE-073-00-HD1	63%			Slight		
RE-073-00-HD2	59%	69%		Slight	Slight	
RE-073-00-HD5	85%			Non		
RF-082-00-HD1	56%			Slight		
RF-082-00-HD2	70%			Slight		
RF-082-00-HD3	70%	71%	71%	Slight	Slight	Slight
RF-082-00-HD4	59%			Slight		
RF-082-00-HD5	100%			Non		
RG-136-00-HD1	100%			Non		
RG-136-00-HD2	104%			Non		
RG-136-00-HD3	104%	99%		Non	Non	
RG-136-00-HD4	100%			Non		
RG-136-00-HD5	89%		95%	Non		Non
RG-137-50-HD1	96%			Non		
RG-137-50-HD2	93%			Non		
RG-137-50-HD3	78%	90%		Slight	Non	
RG-137-50-HD4	96%			Non		
RG-137-50-HD5	89%			Non		
RH-143-00-HD1	96%			Non		
RH-143-00-HD2	93%	94%		Non	Non	
RH-143-00-HD3	93%			Non		
RH-144-50-HD1	67%			Slight		
RH-144-50-HD2	89%			Non		
RH-144-50-HD3	81%	84%		Non to slight	Non	
RH-144-50-HD4	93%		80%	Non		Non to slight
RH-144-50-HD5	93%			Non		
RH-150-00-HD1	48%			Moderate		
RH-150-00-HD2	67%			Slight		
RH-150-00-HD3	74%	67%		Slight	Slight	
RH-150-00-HD4	67%			Slight		
RH-150-00-HD5	78%			Slight		
RI-164-00-HD1	78%			Slight		
RI-164-00-HD2	74%			Slight		
RI-164-00-HD3	85%	84%		Non	Non	
RI-164-00-HD4	89%			Non		
RI-164-00-HD5	93%			Non		
RI-164-50-HD1	44%			Moderate		
RI-164-50-HD2	41%			Moderate		
RI-164-50-HD3	48%	44%	70%	Moderate	Moderate	Slight
RI-164-50-HD4	52%			Slight to moderate		
RI-164-50-HD5	37%			Moderate		
RI-168-50-HD1	81%			Non to slight		
RI-168-50-HD2	70%			Slight		
RI-168-50-HD3	89%	81%		Non	Non to slight	
RI-168-50-HD4	93%			Non		
RI-168-50-HD5	74%			Slight		
RK-201-00-HD1	93%			Non		
RK-201-00-HD2	63%			Slight		
RK-201-00-HD3	81%	81%	81%	Non to slight	Non to slight	Non to slight
RK-201-00-HD4	81%			Non to slight		
RK-201-00-HD5	89%			Non		
RM-285-00-HD1	93%			Non		
RM-285-00-HD2	96%			Non		
RM-285-00-HD3	93%	94%	94%	Non	Non	Non
RM-285-00-HD4	93%			Non		
RM-285-00-HD5	96%			Non		
TR-REF-01-HD1	89%			Non		
TR-REF-01-HD2	85%			Non		
TR-REF-01-HD3	89%	91%		Non	Non	
TR-REF-01-HD4	89%			Non		
TR-REF-01-HD5	104%		98%	Non		Non
TR-REF-02-HD1	104%			Non		
TR-REF-02-HD2	115%			Non		
TR-REF-02-HD3	100%	104%		Non	Non	
TR-REF-02-HD4	104%			Non		
TR-REF-02-HD5	100%			Non		
CR-REF-01-HD1	96%			Non		
CR-REF-01-HD2	96%			Non		
CR-REF-01-HD3	85%	89%		Non	Non	
CR-REF-01-HD4	81%			Non to slight		
CR-REF-01-HD5	85%		93%	Non		Non
CR-REF-02-HD1	104%			Non		
CR-REF-02-HD2	89%			Non		
CR-REF-02-HD3	104%	96%		Non	Non	
CR-REF-02-HD4	89%			Non		
CR-REF-02-HD5	96%			Non		
RA-003-50-HD1	93%			Non		
RA-003-50-HD2	67%			Slight		
RA-003-50-HD3	93%	83%		Non	Non to slight	
RA-003-50-HD4	81%			Non to slight		
RA-003-50-HD5	81%		75%	Non to slight		Slight
RB-012-50-HD1	74%			Slight		
RB-012-50-HD2	63%			Slight		
RB-012-50-HD3	70%	67%		Slight	Slight	
RB-012-50-HD4	52%			Slight to moderate		
RB-012-50-HD5	74%			Slight		
Composite Reference Mean						

HBI: Hilsenoff Biotic Index
EPA: United States Environmental Protection Agency

Table 4-4b. Summary of EPA Biological Condition Scores Hester Dendy Samples: Reach and Locations

Location	Biological Condition Category Based on EPA Multi-Metric Scoring Compared to Composite Reference (Hester-Dendy) (a)	
	Locations	Reaches
Composite Reference	Non Impaired	Non Impaired
TR-Ref-01	Non Impaired	Non Impaired
TR-Ref-02	Non Impaired	
CR-Ref-01	Non Impaired	Non Impaired
CR-Ref-02	Non Impaired	
RA-003-50	Non- to slightly Impaired	Slightly Impaired
RB-012-50	Slightly Impaired	
RE-061-00	Non Impaired	Non Impaired
RE-062-00*	Non Impaired	
RE-073-00*	Slightly Impaired	
RF-082-00*	Slightly Impaired	Slightly Impaired
RG-136-00	Non Impaired	Non Impaired
RG-137-50	Non Impaired	
RH-143-00	Non Impaired	Non- to slightly Impaired
RH-144-50	Non Impaired	
RH-150-00*	Slightly Impaired	
RI-164-00	Non Impaired	Slightly Impaired
RI-164-50	Moderately Impaired	
RI-168-50	Non- to slightly Impaired	
RK-201-00	Non- to slightly Impaired	Non- to slightly Impaired
RM-285-00	Non Impaired	Non Impaired

- (a) Note that impairment may be related to habitat quality. Figure 5-2 overlays benthic community scoring results and habitat scoring results so these relationships can be considered. Statistical testing was also conducted and results showed that there are no significant differences between Reaches E through M and the Composite Reference, but there is a statistically significant differences between Location RI-164+50 and the Composite Reference. RI-164+50 had one of the lower habitat scores among all locations.

* Sediment Management Area

EPA: United States Environmental Protection Agency

Table 4-5a. EPA Multi-Metric Scoring for Sweep Samples Compared to the Composite Reference: Reach and Locations

Location	<u>Biological Metrics</u>										
	Taxa Richness	# of Mayfly Taxa	# of Stonefly Taxa	# of Caddisfly Taxa	% Mayfly Comp	% Caddisfly Comp	% Dominant Taxon	% Isopods, Snails, Leeches	% Surface Dependent	HBI	Ratio of Filterers/Total
RE-062-00-IC-SP1	39	5	0	8	8.3	42.6	15.5	0.3	0.0	4.7	0.53
RE-077-50-IC-SP1	41	8	1	7	6.0	10.7	29.6	4.7	0.0	5.9	0.24
RF-085-00-IC-SP1	33	6	1	5	5.5	32.0	18.9	1.1	0.0	4.5	0.55
RG-140-00-IC-SP1	37	6	0	9	7.5	27.4	21.6	2.1	0.0	5.6	0.40
RH-153-50-IC-SP1	40	6	1	10	24.8	10.0	30.5	5.9	0.0	5.4	0.21
RI-169-50-IC-SP1	37	5	0	7	4.5	8.9	28.9	6.6	0.0	6.1	0.23
RK-201-00-IC-SP1	40	6	1	8	15.7	12.0	27.4	0.8	0.3	6.2	0.23
RM-285-00-IC-SP1	40	6	1	5	13.4	31.0	19.5	4.1	0.0	5.8	0.35
TR-Ref-01-SP1	47	9	1	7	8.0	39.5	25.4	3.6	0.5	4.6	0.42
TR-Ref-02-SP1	38	7	1	7	23.8	29.4	18.0	5.4	0.0	4.6	0.29
CR-Ref-01-IC-SP1	42	7	1	9	19.5	30.9	13.2	2.0	0.0	4.6	0.41
CR-Ref-02-IC-SP1	42	7	1	9	17.7	25.7	16.7	2.7	0.8	4.7	0.29
RA-Ref-01-IC-SP1	36	5	0	2	1.9	0.5	39.5	3.8	2.1	6.9	0.04
RB-013-00-IC-SP1	39	7	0	4	5.4	2.2	18.5	15.1	0.2	6.0	0.05
Composite Reference Mean	41	7	1	6	12.7	21.4	21.9	5.4	0.6	5.2	0.25

Table 4-5a. EPA Multi-Metric Scoring for Sweep Samples Compared to the Composite Reference: Reach and Locations

Location	<u>Biological Condition Score</u>										
	Taxa Richness	# of Mayfly Taxa	# of Stonefly Taxa	# of Caddisfly Taxa	% Mayfly Comp	% Caddisfly Comp	% Dominant Taxon	% Isopods, Snails, Leeches	% Surface Dependent	HBI	Ratio of Filterers/Total
RE-062-00-IC-SP1	96%	71%	0%	126%	8%	43%	15%	0%	0%	111%	211%
RE-077-50-IC-SP1	101%	114%	150%	111%	6%	11%	30%	5%	0%	89%	95%
RF-085-00-IC-SP1	81%	86%	150%	79%	6%	32%	19%	1%	0%	116%	220%
RG-140-00-IC-SP1	91%	86%	0%	142%	8%	27%	22%	2%	0%	94%	159%
RH-153-50-IC-SP1	98%	86%	150%	158%	25%	10%	31%	6%	0%	96%	85%
RI-169-50-IC-SP1	91%	71%	0%	111%	5%	9%	29%	7%	0%	86%	93%
RK-201-00-IC-SP1	98%	86%	150%	126%	16%	12%	27%	1%	0%	84%	90%
RM-285-00-IC-SP1	98%	86%	150%	79%	13%	31%	19%	4%	0%	90%	138%
TR-Ref-01-SP1	116%	129%	150%	111%	8%	40%	25%	4%	1%	114%	169%
TR-Ref-02-SP1	93%	100%	150%	111%	24%	29%	18%	5%	0%	114%	117%
CR-Ref-01-IC-SP1	103%	100%	150%	142%	20%	31%	13%	2%	0%	115%	164%
CR-Ref-02-IC-SP1	103%	100%	150%	142%	18%	26%	17%	3%	1%	111%	115%
RA-Ref-01-IC-SP1	89%	71%	0%	32%	2%	0%	40%	4%	2%	75%	16%
RB-013-00-IC-SP1	96%	100%	0%	63%	5%	2%	19%	15%	0%	87%	20%
Composite Reference Mean	100%	100%	100%	100%	13%	21%	22%	5%	1%	100%	100%

Table 4-5a. EPA Multi-Metric Scoring for Sweep Samples Compared to the Composite Reference: Reach and Locations

Location	<u>Metric Score</u>											
	Taxa Richness	# of Mayfly Taxa	# of Stonefly Taxa	# of Caddisfly Taxa	% Mayfly Comp	% Caddisfly Comp	% Dominant Taxon	% Isopods, Snails, Leeches	% Surface Dependent	HBI	Ratio of Filterers/Total	Total
RE-062-00-IC-SP1	6	4	0	6	0	6	6	6	6	6	6	52
RE-077-50-IC-SP1	6	6	6	6	0	4	4	6	6	6	6	56
RF-085-00-IC-SP1	6	6	6	4	0	6	6	6	6	6	6	58
RG-140-00-IC-SP1	6	6	0	6	0	6	4	6	6	6	6	52
RH-153-50-IC-SP1	6	6	6	6	6	4	2	6	6	6	6	60
RI-169-50-IC-SP1	6	4	0	6	0	4	4	4	6	6	6	46
RK-201-00-IC-SP1	6	6	6	6	4	4	4	6	6	4	6	58
RM-285-00-IC-SP1	6	6	6	4	0	6	6	6	6	6	6	58
TR-Ref-01-SP1	6	6	6	6	0	6	4	6	6	6	6	58
TR-Ref-02-SP1	6	6	6	6	6	6	6	6	6	6	6	66
CR-Ref-01-IC-SP1	6	6	6	6	4	6	6	6	6	6	6	64
CR-Ref-02-IC-SP1	6	6	6	6	4	6	6	6	6	6	6	64
RA-Ref-01-IC-SP1	6	4	0	0	0	0	2	6	6	4	0	28
RB-013-00-IC-SP1	6	6	0	4	0	2	6	0	6	6	0	36
Composite Reference Mean	6	6	6	6	0	4	4	6	6	6	6	56

Table 4-5a. EPA Multi-Metric Scoring for Sweep Samples Compared to the Composite Reference: Reach and Locations

Location	<u>Biological Condition Category</u>			
	% of Reference (location)	% of Reference (reach)	Biological Condition Category (location)	Biological Condition Category (reach)
RE-062-00-IC-SP1	93%	96%	Non	Non
RE-077-50-IC-SP1	100%		Non	
RF-085-00-IC-SP1	104%	104%	Non	Non
RG-140-00-IC-SP1	93%	93%	Non	Non
RH-153-50-IC-SP1	107%	107%	Non	Non
RI-169-50-IC-SP1	82%	82%	Non to slight	Non to slight
RK-201-00-IC-SP1	104%	104%	Non	Non
RM-285-00-IC-SP1	104%	104%	Non	Non
TR-Ref-01-SP1	104%	111%	Non	Non
TR-Ref-02-SP1	118%		Non	
CR-Ref-01-IC-SP1	114%	114%	Non	Non
CR-Ref-02-IC-SP1	114%		Non	
RA-Ref-01-IC-SP1	50%	57%	Moderate	Slight
RB-013-00-IC-SP1	64%		Slight	
Composite Reference Mean				

HBI: Hilsenhoff Biotic Index
EPA: United States Environmental Protection Agency

**Table 4-5b. Summary of EPA Biological Condition Scores for Sweep Samples:
Reach and Location**

Location	Biological Condition Category Based on EPA Multi-Metric Scoring Compared to Composite Reference (Sweep) (a)	
	Locations	Reaches
Composite Reference	Non Impaired	Non Impaired
TR-Ref-01	Non Impaired	Non Impaired
TR-Ref-02	Non Impaired	
CR-Ref-01	Non Impaired	
CR-Ref-02	Non Impaired	Non Impaired
RA-Ref-01	Moderately Impaired	
RB-013-00	Slightly Impaired	
RE-062-00*	Non Impaired	Non Impaired
RE-077-50	Non Impaired	
RF-085-00	Non Impaired	
RG-140-00	Non Impaired	Non Impaired
RH-153-50	Non Impaired	Non Impaired
RI-169-50	Non- to slightly Impaired	Non- to slightly Impaired
RK-201-00	Non Impaired	Non Impaired
RM-285-00	Non Impaired	Non Impaired

(a) Note that impairment may be related to habitat quality. Figure 5-2 overlays benthic community scoring results and habitat scoring results so these relationships can be considered. Reach A was among the locations with the lowest habitat scores.

EPA: United States Environmental Protection Agency
* Sediment Management Area

**Table 4-6a. DNRE Multi-Metric Scoring for Sweep Samples Compared to the Michigan Ecoregional Reference:
Reach and Locations**

Location	<u>Biological Metrics</u>								
	Taxa Richness	Mayfly Taxa Richness	Caddisfly Taxa Richness	Stonefly Taxa Richness	% Mayfly	% Caddisfly	% Dominance	% Isopod, Snail, Leech	% Surface Dependent
TR-Ref-01-SP1	47	9	7	1	8	40	25	4	7
TR-Ref-02-SP1	38	7	7	1	24	29	18	5	24
CR-Ref-01-IC-SP1	42	7	9	1	20	31	13	2	8
CR-Ref-02-IC-SP1	42	7	9	1	18	26	17	3	2
RA-Ref-01-IC-SP1	36	5	2	0	2	0	40	4	3
RB-013-00-IC-SP1	39	7	4	0	5	2	19	15	8
RE-062-00-IC-SP1	39	5	8	0	8	43	15	0	19
RE-077-50-IC-SP1	41	8	7	1	6	11	30	5	8
RF-085-00-IC-SP1	33	6	5	1	6	32	19	1	2
RG-140-00-IC-SP1	37	6	9	0	8	27	22	2	4
RH-153-50-IC-SP1	40	6	10	1	25	10	31	6	4
RI-169-50-IC-SP1	37	5	7	0	5	9	29	7	6
RK-201-00-IC-SP1	40	6	8	1	16	12	27	1	4
RM-285-00-IC-SP1	40	6	5	1	13	31	19	4	7

**Table 4-6a. DNRE Multi-Metric Scoring for Sweep Samples Compared to the Michigan Ecoregional Reference:
Reach and Locations**

Location	<u>Biosurvey Metric</u>								
	Taxa Richness	Mayfly Taxa Richness	Caddisfly Taxa Richness	Stonefly Taxa Richness	% Mayfly	% Caddisfly	% Dominance	% Isopod, Snail, Leech	% Surface Dependent
TR-Ref-01-SP1	1	1	1	1	-1	1	-1	1	1
TR-Ref-02-SP1	1	1	1	1	1	1	0	1	0
CR-Ref-01-IC-SP1	1	1	1	1	0	1	1	1	1
CR-Ref-02-IC-SP1	1	1	1	1	0	1	0	1	1
RA-Ref-01-IC-SP1	1	1	0	-1	-1	-1	-1	1	1
RB-013-00-IC-SP1	1	1	1	-1	-1	0	0	-1	1
RE-062-00-IC-SP1	1	1	1	-1	-1	1	1	1	0
RE-077-50-IC-SP1	1	1	1	1	-1	0	-1	1	1
RF-085-00-IC-SP1	1	1	1	1	-1	1	0	1	1
RG-140-00-IC-SP1	1	1	1	-1	-1	1	0	1	1
RH-153-50-IC-SP1	1	1	1	1	1	0	-1	1	1
RI-169-50-IC-SP1	1	1	1	-1	-1	0	-1	0	1
RK-201-00-IC-SP1	1	1	1	1	0	0	-1	1	1
RM-285-00-IC-SP1	1	1	1	1	-1	1	0	1	1

**Table 4-6a. DNRE Multi-Metric Scoring for Sweep Samples Compared to the Michigan Ecoregional Reference:
Reach and Locations**

Location	<u>Biosurvey Category</u>			
	Total (location)	Total (Reach)	Biological Condition (location)	Biological Condition (Reach)
TR-Ref-01-SP1	5	6	excellent	excellent
TR-Ref-02-SP1	7		excellent	
CR-Ref-01-IC-SP1	8	7.5	excellent	excellent
CR-Ref-02-IC-SP1	7		excellent	
RA-Ref-01-IC-SP1	0	0.5	neutral	tending toward excellent
RB-013-00-IC-SP1	1		tending toward excellent	
RE-062-00-IC-SP1	4	4	tending toward excellent	tending toward excellent
RE-077-50-IC-SP1	4		tending toward excellent	
RF-085-00-IC-SP1	6	6	excellent	excellent
RG-140-00-IC-SP1	4	4	tending toward excellent	tending toward excellent
RH-153-50-IC-SP1	6	6	excellent	excellent
RI-169-50-IC-SP1	1	1	tending toward excellent	tending toward excellent
RK-201-00-IC-SP1	5	5	excellent	excellent
RM-285-00-IC-SP1	6	6	excellent	excellent

DNRE: Michigan Department of Natural Resources and Environment
HELP: Huron/Erie Lake Plain

**Table 4-6b. Summary of DNRE Biological Condition Scores for Sweep Samples:
Reach and Locations**

Location	Biological Condition Category Based on DNRE Multi-Metric Scoring Compared to the HELP Ecoregional Reference (Sweep)	
	Locations	Reaches
Composite Reference	excellent	excellent
TR-Ref-01-SP1	excellent	excellent
TR-Ref-02-SP1	excellent	
CR-Ref-01-IC-SP1	excellent	excellent
CR-Ref-02-IC-SP1	excellent	
RA-Ref-01-IC-SP1	neutral	tending toward excellent
RB-013-00-IC-SP1	tending toward excellent	
RE-062-00-IC-SP1	tending toward excellent	tending toward excellent
RE-077-50-IC-SP1	tending toward excellent	
RF-085-00-IC-SP1	excellent	excellent
RG-140-00-IC-SP1	tending toward excellent	tending toward excellent
RH-153-50-IC-SP1	excellent	excellent
RI-169-50-IC-SP1	tending toward excellent	tending toward excellent
RK-201-00-IC-SP1	excellent	excellent
RM-285-00-IC-SP1	excellent	excellent

DNRE: Michigan Department of Natural Resources and Environment

HELP: Huron/Erie Lake Plain

Table 5-1: Overall Summary of EPA and DNRE Biological Condition Scores for the Reaches

Reach	EPA Metrics Compared to Composite Reference (a)			DNRE Ecoregional Comparison
	Grab	Hester-Dendy	Sweep	Sweep
Composite Reference	Non-Impaired	Non-Impaired	Non-Impaired	excellent
TR Ref	Non-Impaired	Non-Impaired	Non-Impaired	excellent
CR Ref	Slightly Impaired	Non-Impaired	Non-Impaired	excellent
Reach A/B	Slightly Impaired	Slightly Impaired	Slightly Impaired	tending toward excellent
Reach E	Non-Impaired	Non-Impaired	Non-Impaired	tending toward excellent
Reach F	Non- to Slightly Impaired	Slightly Impaired	Non-Impaired	excellent
Reach G	Non- to Slightly Impaired	Non-Impaired	Non-Impaired	tending toward excellent
Reach H	Slightly Impaired	Non- to Slightly Impaired	Non-Impaired	excellent
Reach I	Slightly Impaired	Slightly Impaired	Non- to Slightly Impaired	tending toward excellent
Reach K	Non-Impaired	Non- to Slightly Impaired	Non-Impaired	excellent
Reach M	Non-Impaired	Non-Impaired	Non-Impaired	excellent

(a) Refer to Tables 4-3b, 4-4b, and 4-5b for discussions of habitat quality contributions to scoring. Note that statistical testing did not show any statistically significant differences between Reaches and the Composite References.

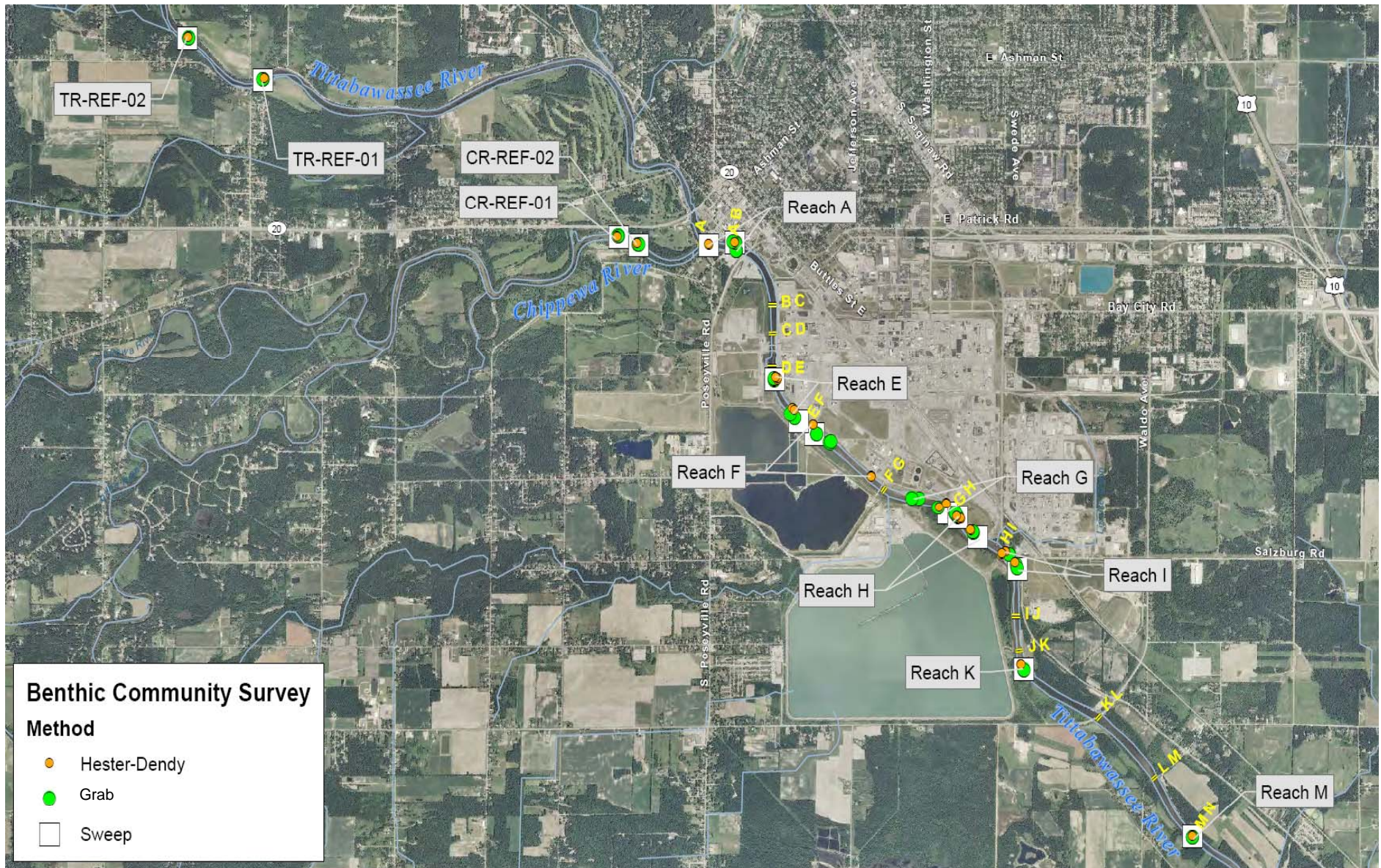
DNRE: Michigan Department of Natural Resources and Environment
EPA: Environmental Protection Agency

Appendix A:
Photo Log

Appendix A

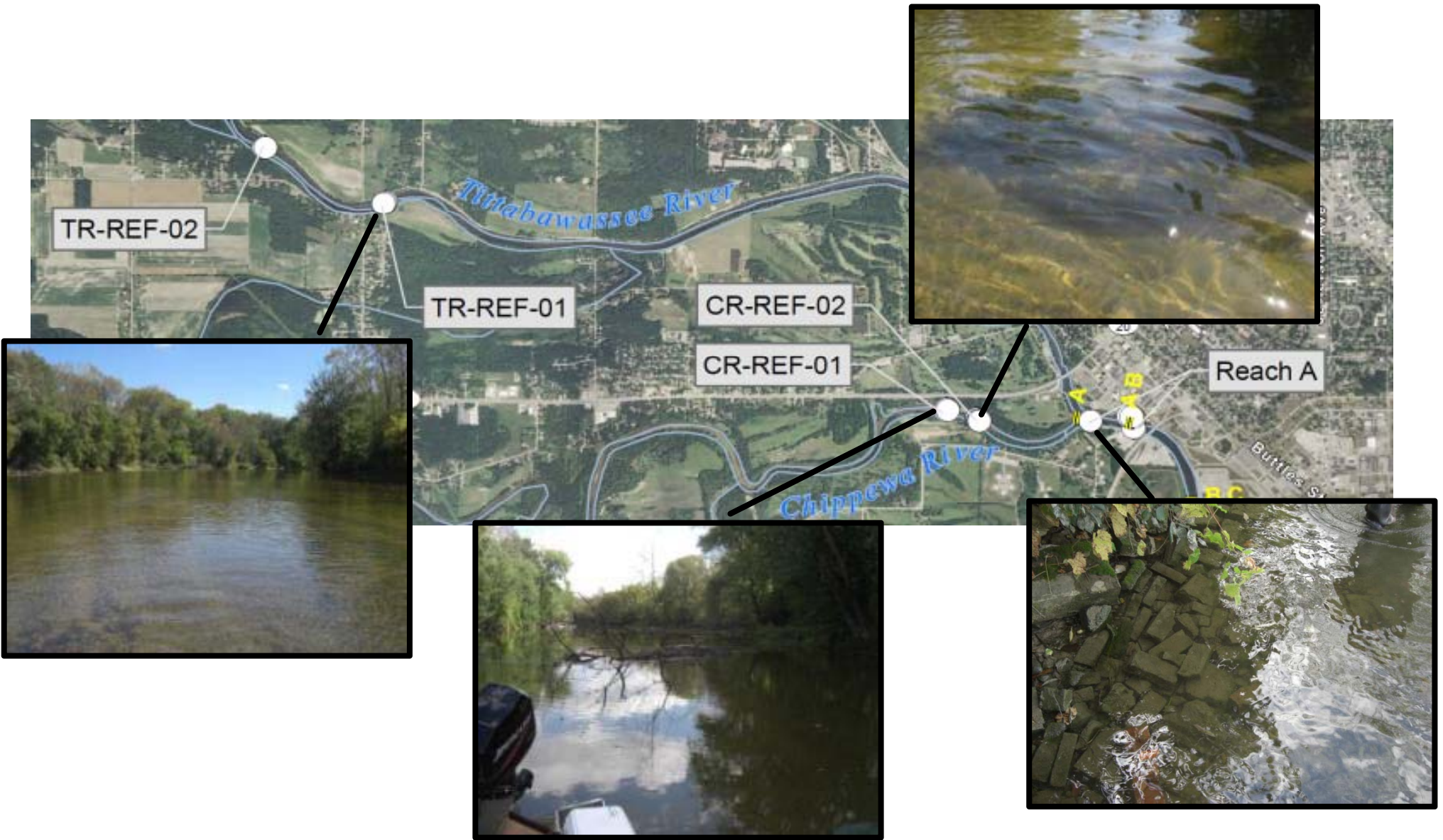
Photo Log





Benthic Community Assessment: Location Overview
Benthic Community Assessment

Figure
A-1



Reference Stations
Benthic Community Assessment

Figure
A-2



Reference Stations: Tittabawassee River Locations

Deployment: 9/29/10 & 9/30/10
Benthic Community Assessment

Figure
A-3



TR-REF-02



TR-REF-01

Benthic Community Method

- Hester-Dendy
- Grab
- Sweep



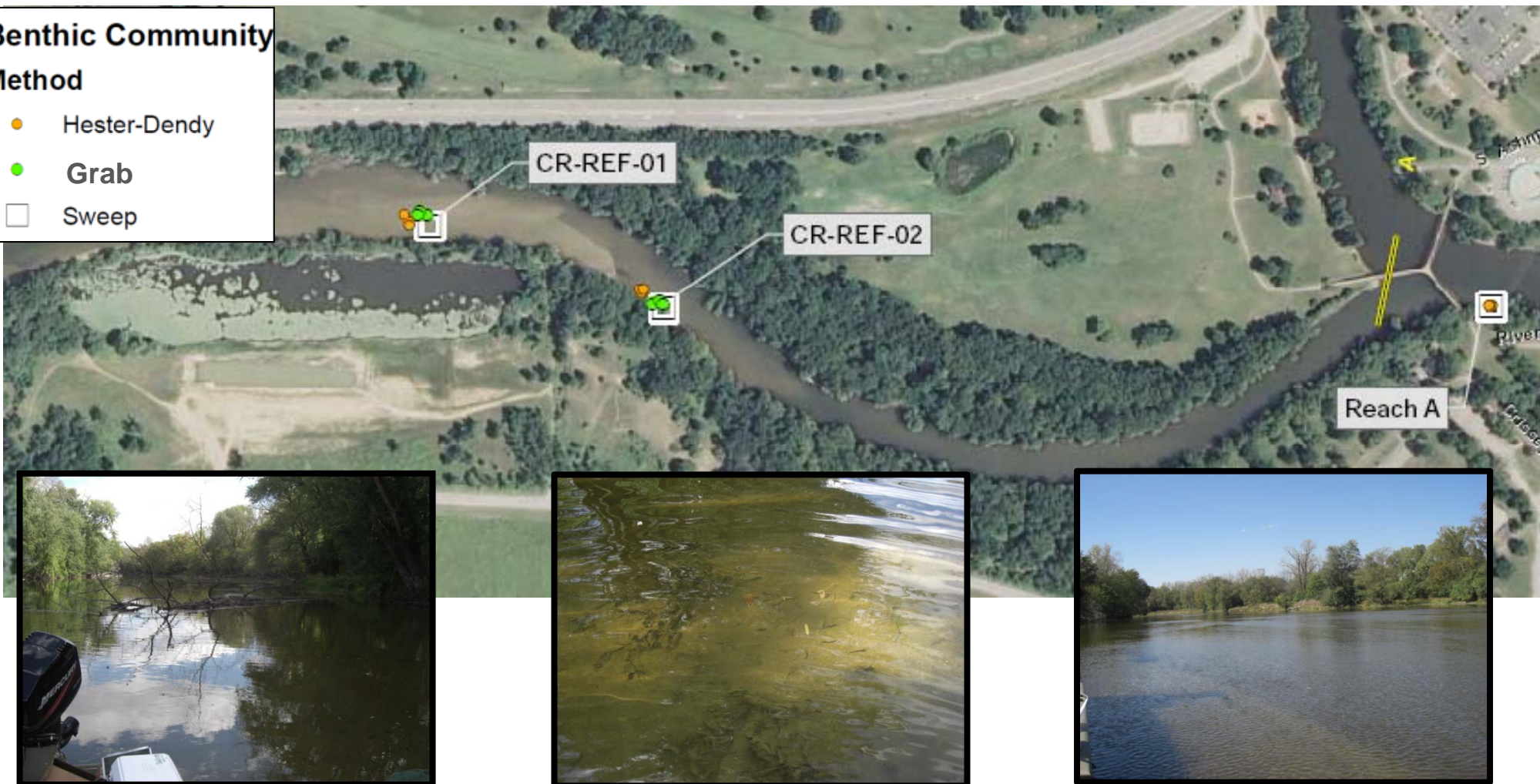
Reference Stations: Tittabawassee River Locations

Recovery: 10/27/10
Benthic Community Assessment

Figure
A-4

Benthic Community Method

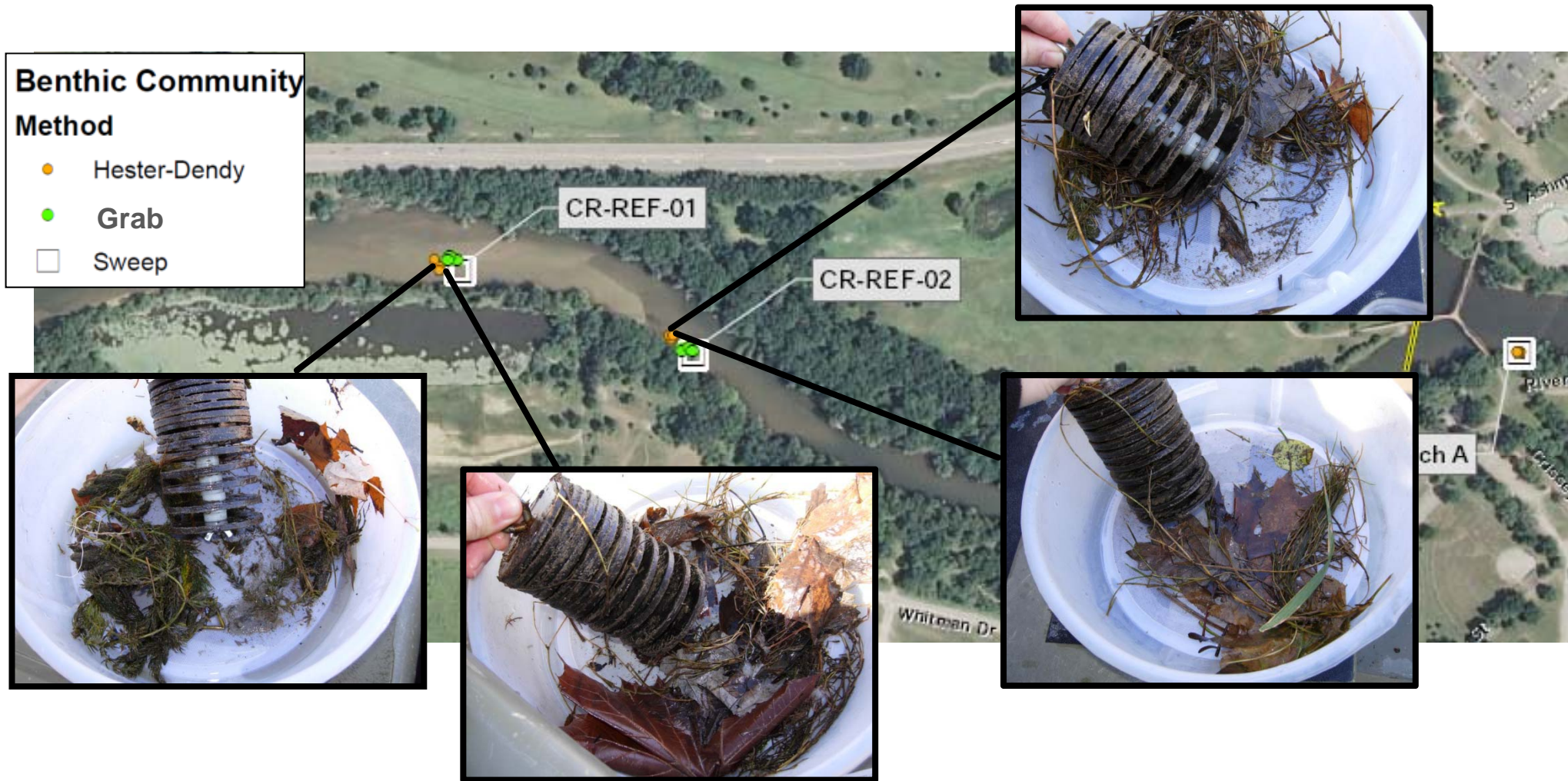
- Hester-Dendy
- Grab
- Sweep



Reference Stations: Chippewa River Locations

Deployment: 9/29/10
Benthic Community Assessment

Figure
A-5



Reference Stations: Chippewa River Locations

Recovery: 10/27/10
Benthic Community Assessment

Figure
A-6

Benthic Community Method

- Hester-Dendy
- Grab
- Sweep



Reference Stations: Reach A & B Locations

Deployment: 9/29/10 & 10/1/10
Benthic Community Assessment

Figure
A-7



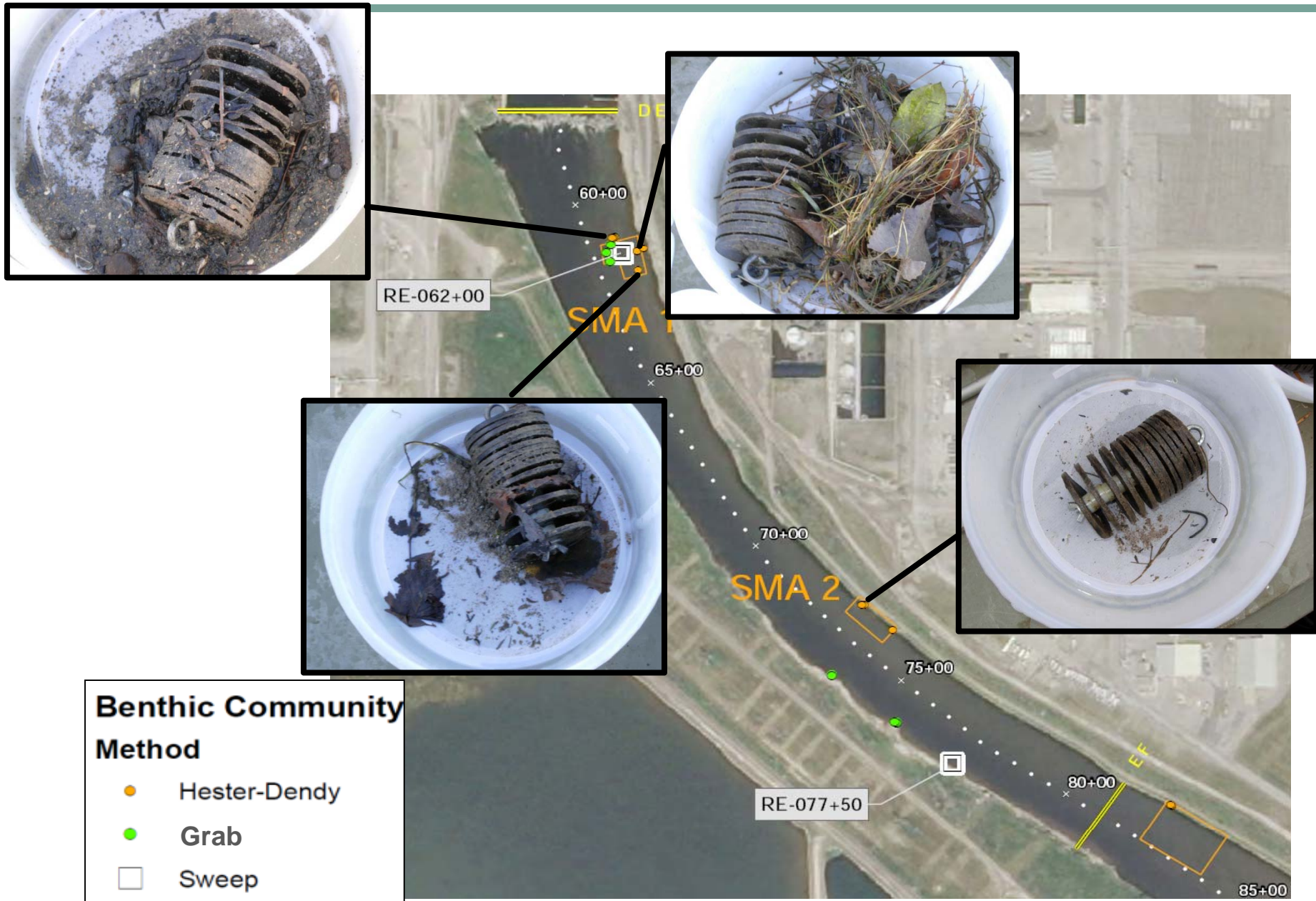
Benthic Community Method

- Hester-Dendy
- Grab
- Sweep



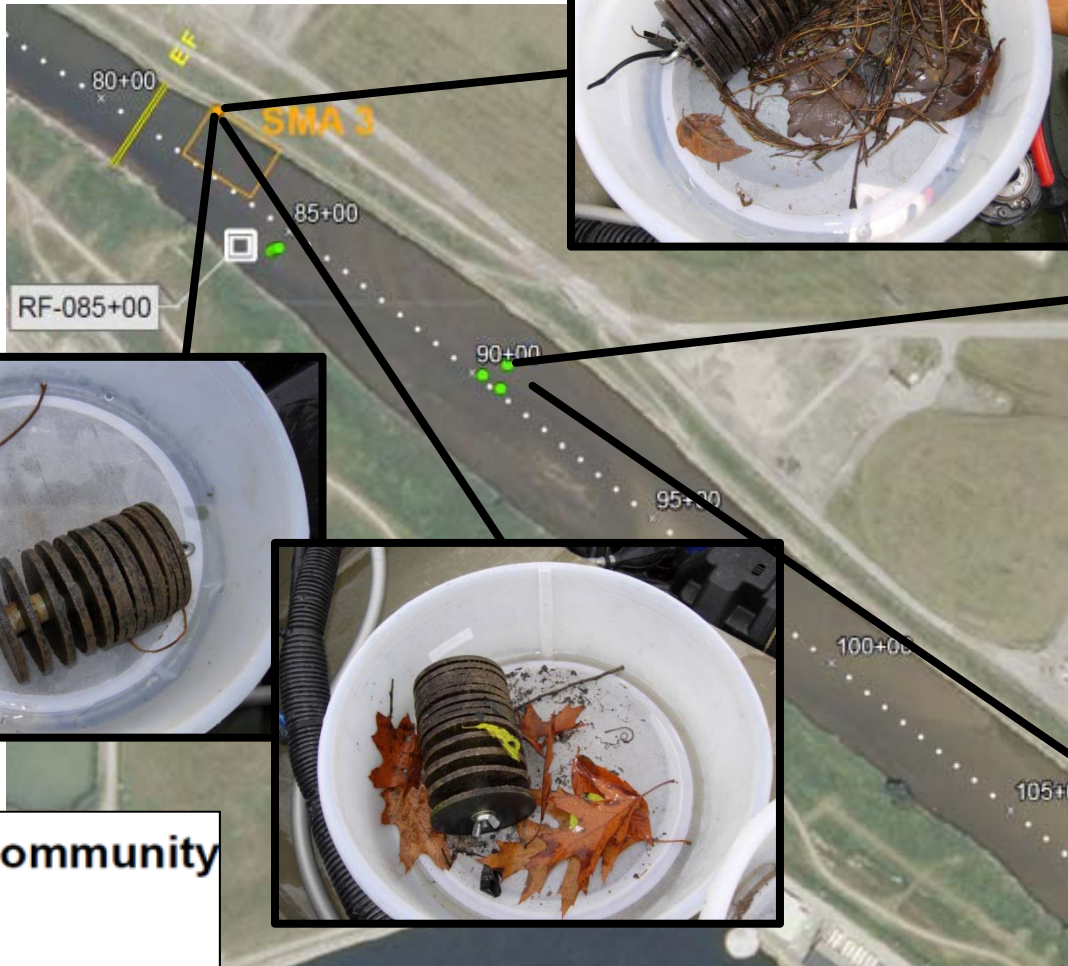
Reach E Locations
Deployment: 9/28/10
Benthic Community Assessment

Figure
A-8



Reach E Locations
 Recovery: 10/29/10
 Benthic Community Assessment

Figure
A-9



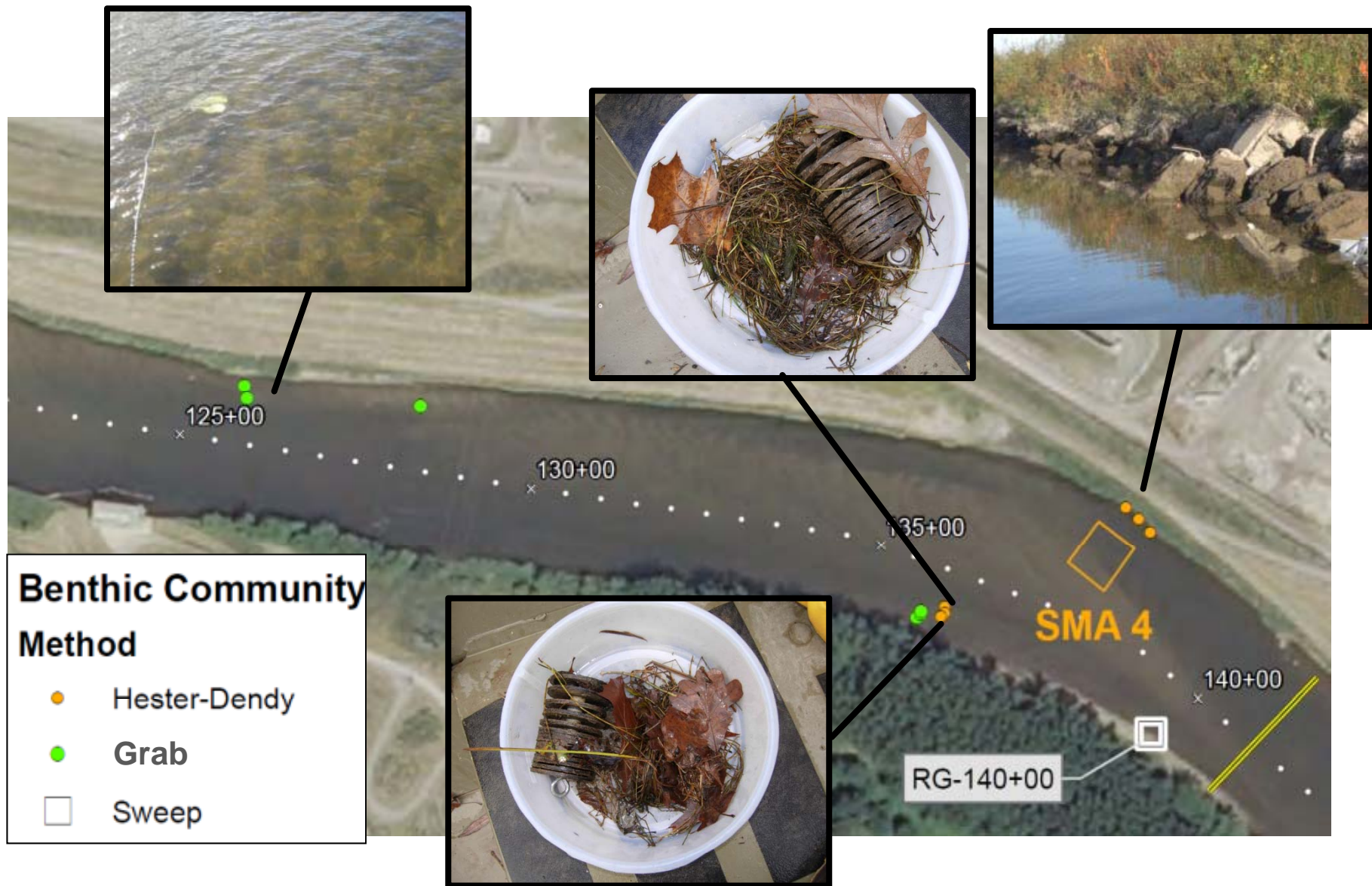
Benthic Community Method

- Hester-Dendy
- Grab
- Sweep



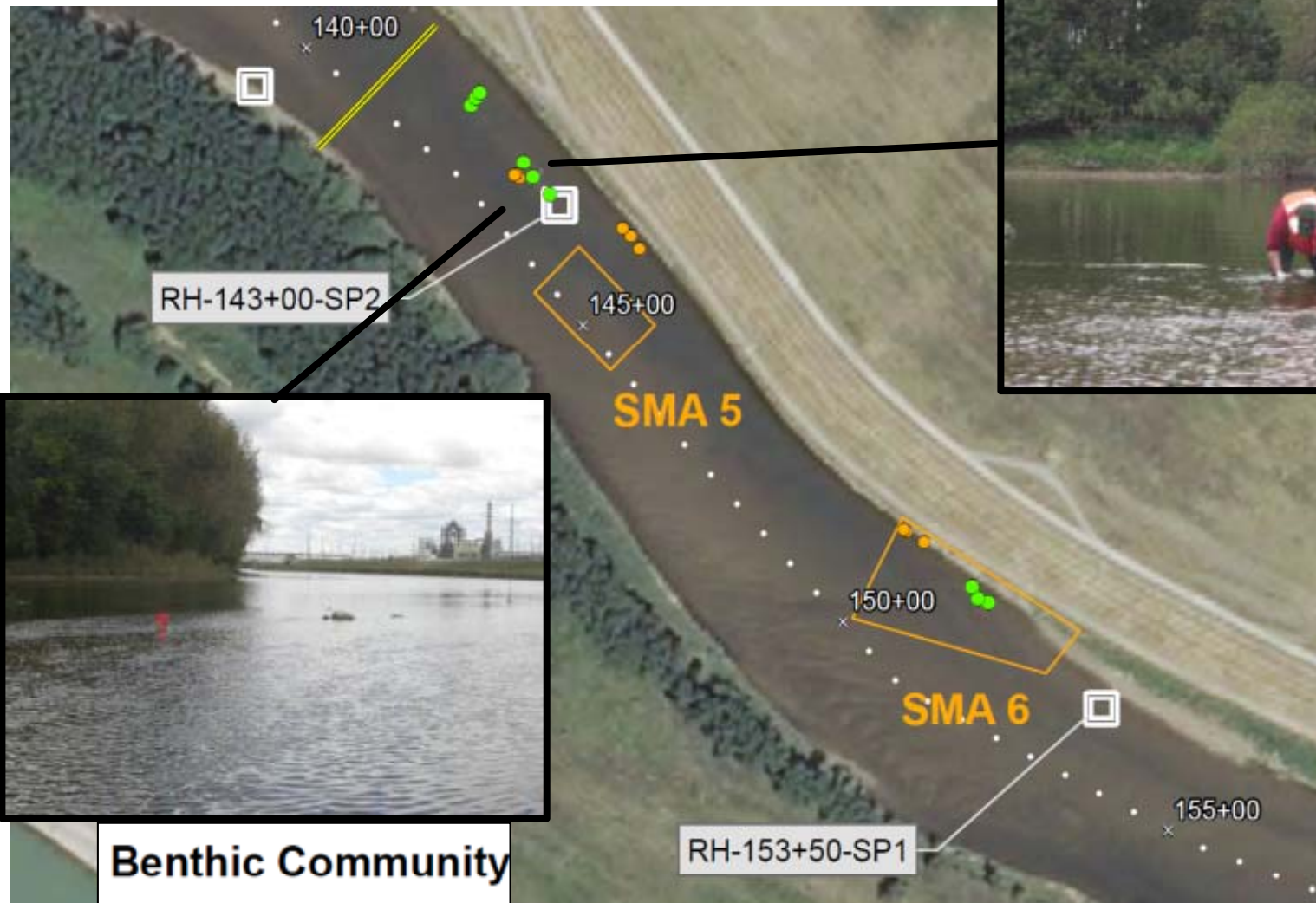
Reach F Locations
Recovery: 10/28/10
Benthic Community Assessment

Figure
A-10



Reach G Locations
 Recovery: 10/28/10
 Benthic Community Assessment

Figure
A-11



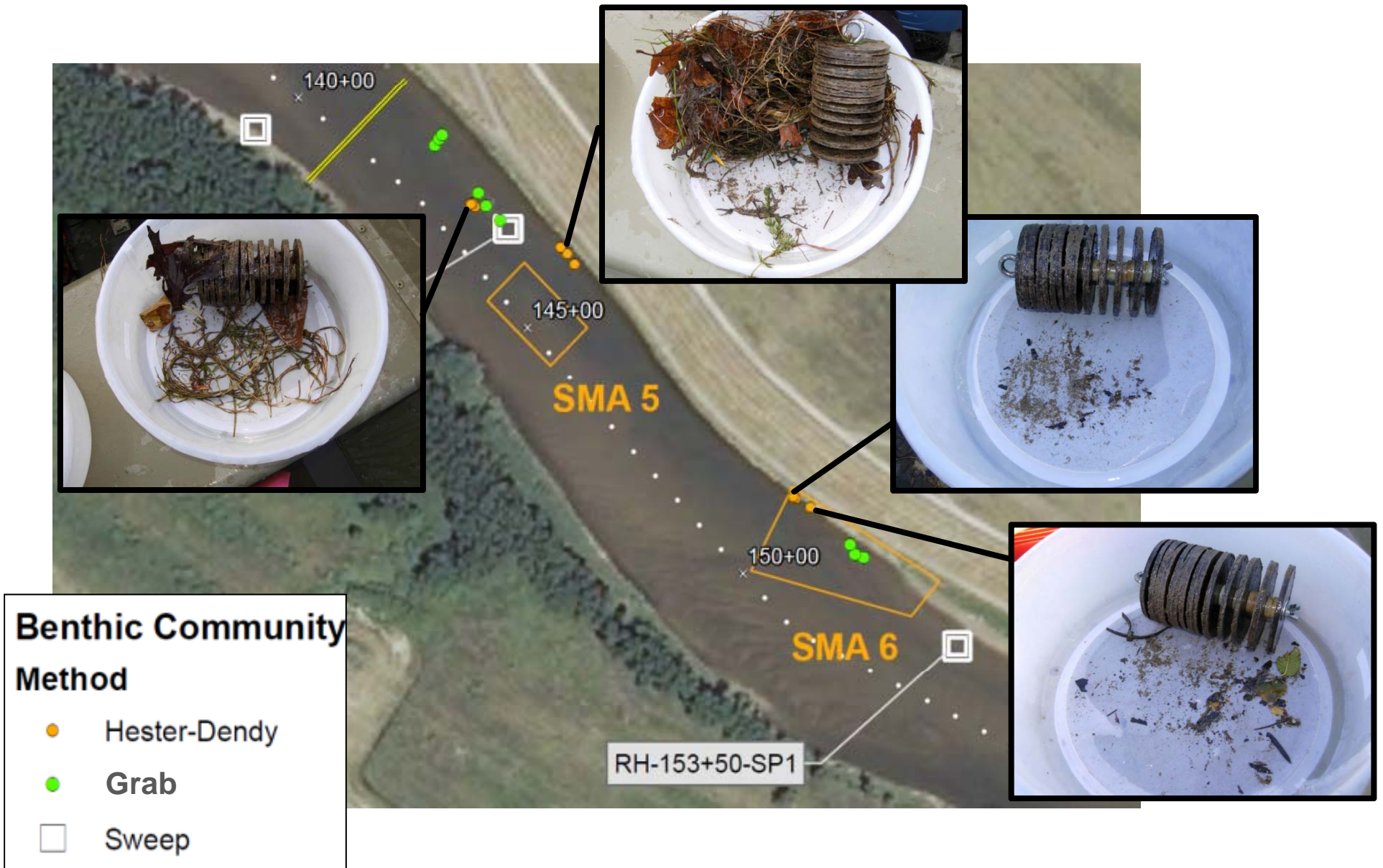
Benthic Community Method

- Hester-Dendy
- Grab
- Sweep

Reach H Locations
Deployment: 9/30/10
Benthic Community Assessment

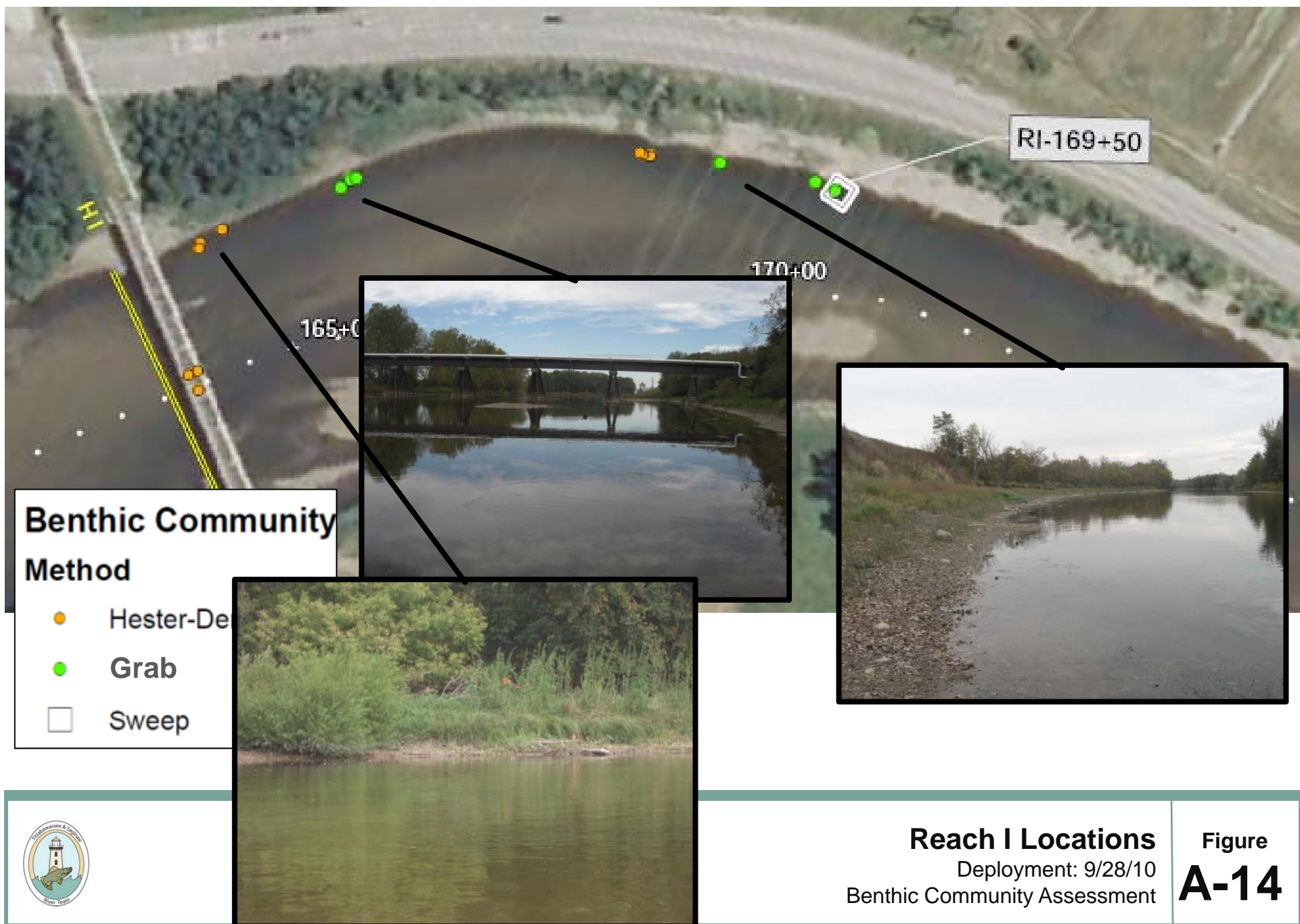
Figure
A-12

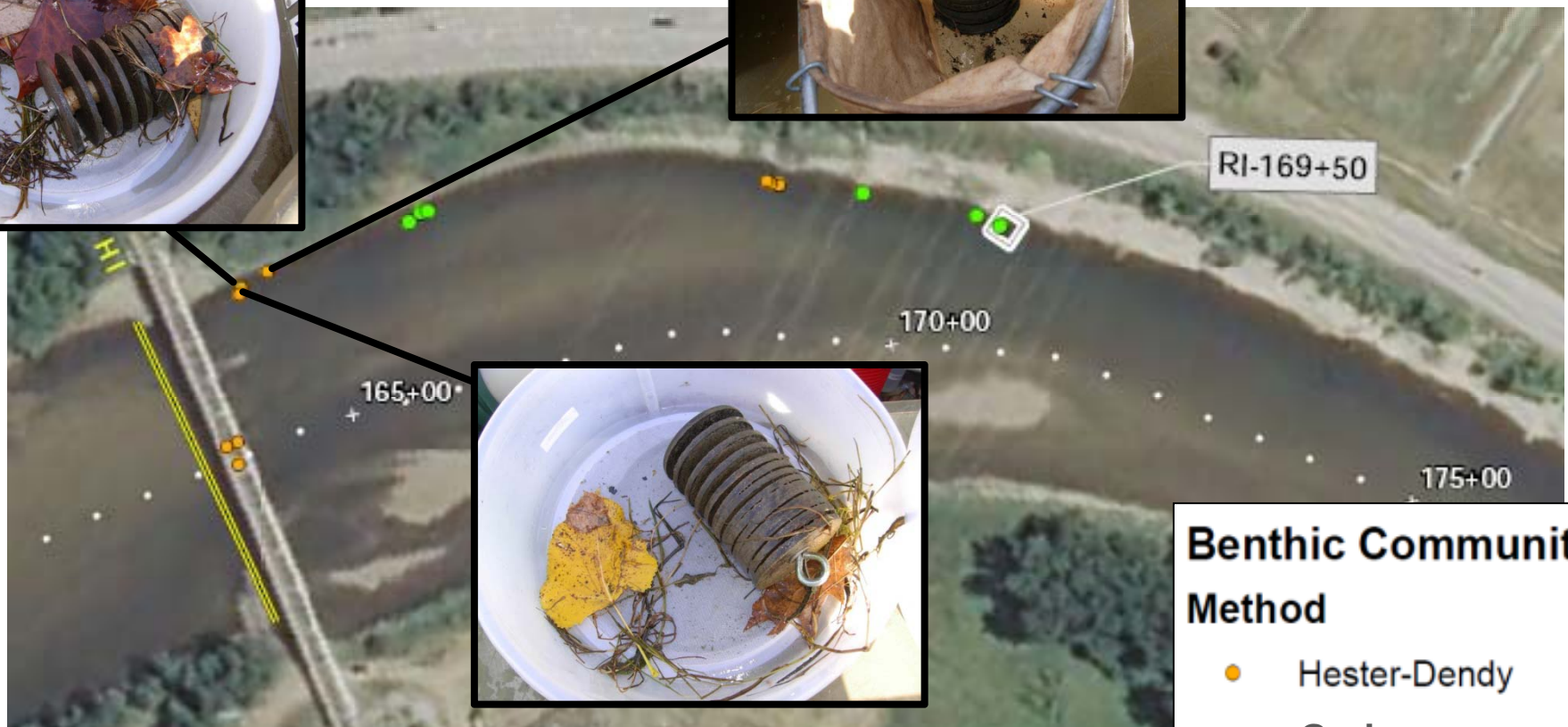




Reach H Locations
 Recovery: 10/28/10
 Benthic Community Assessment

Figure
A-13





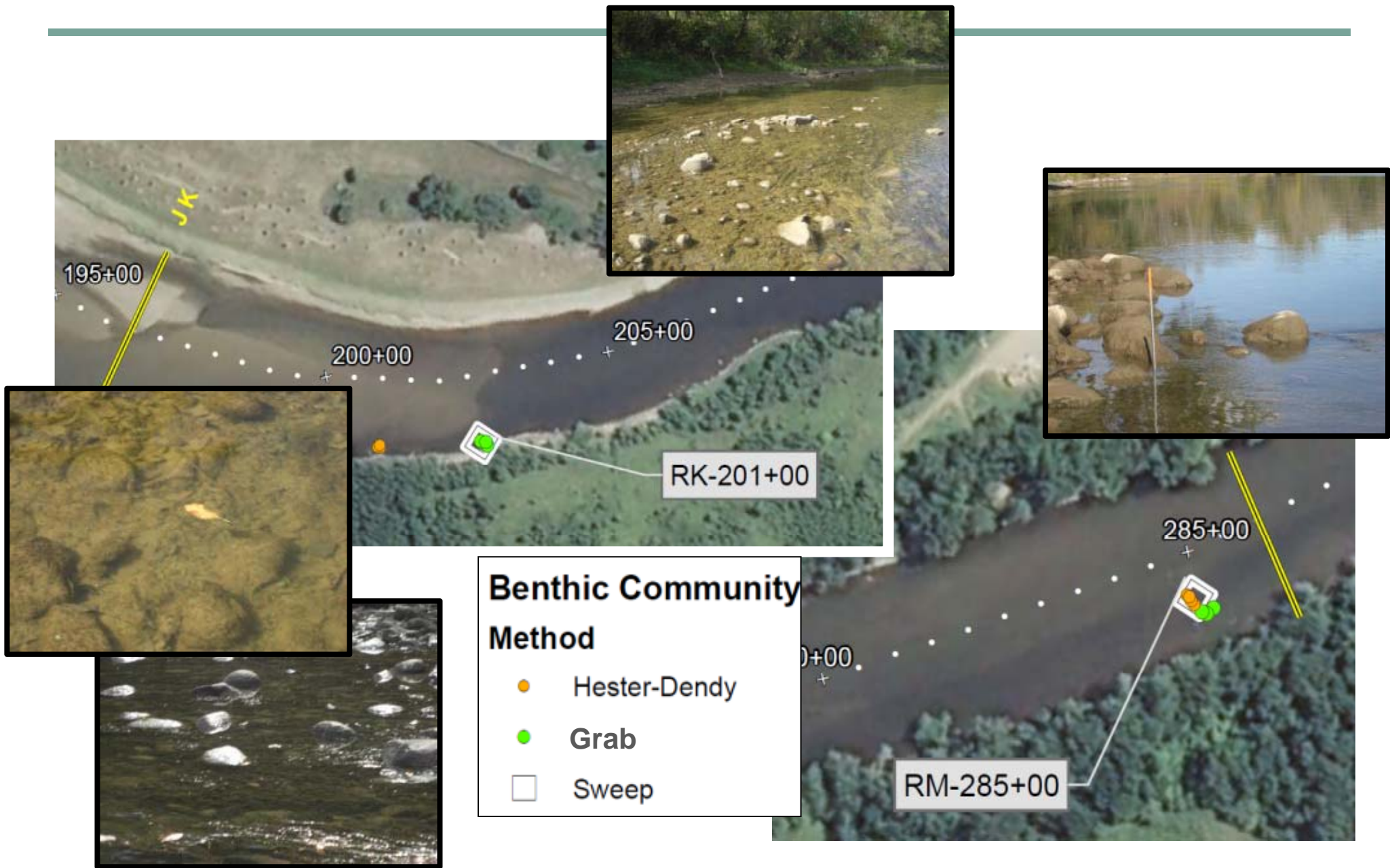
Benthic Community Method

- Hester-Dendy
- Grab
- Sweep



Reach I Locations
Recovery: 10/27/10
Benthic Community Assessment

Figure
A-15



Reach K & M Locations

Deployment: 9/28/10 & 10/1/10
Benthic Community Assessment

Figure
A-16



Benthic Community Method

- Hester-Dendy
- Grab
- Sweep



Reach K & M Locations
Recovery: 10/26/10
Benthic Community Assessment

Figure
A-17

Appendix B:
DEQ 2008 Habitat Scoring Excerpts

**WATER BUREAU
POLICY AND PROCEDURES**

NUMBER:	WB-SWAS-051	
SUBJECT:	QUALITATIVE BIOLOGICAL AND HABITAT SURVEY PROTOCOLS FOR WADEABLE STREAMS AND RIVERS	
EFFECTIVE DATE:	1990, REVISED 1991, 1997, 2002	PAGE: 14 of 53
REVISION DATE:	NOVEMBER 2008	

Five of the habitat metrics discriminate between *Riffle/Run* and *Glide/Pool* streams. Metrics 2, 3, and 7 are paired into separate *Riffle/Run* and *Glide/Pool* metrics (i.e., 2a and 2b). Metrics 1 and 4 each contain criteria for both *Riffle/Run* and *Glide/Pool* systems. In addition flow status (Metric 5) is broken down into 5a and 5b and is intended to measure both the ability of a stream to maintain sufficient base flows, as well as the flow response to runoff events (flashiness).

The site assessment approach for determining the *Riffle/Run* and *Glide/Pool* status of a stream is based on visual observation of the following characteristics:

Riffle/run streams characteristically:

- Demonstrate a regular (repeating) riffle/run sequence.
- Have substrates primarily composed of coarse sediment particles (i.e., coarse sand/gravel or larger particle sizes in high velocity reaches of the stream).
- Tend to have moderate to high gradient landscapes.

Glide/pool streams characteristically:

- Demonstrate primarily a glide/pool sequence.
- Have substrates that are primarily composed of fine sediment (fine sand and smaller). Coarse (gravel or larger) sediment particles may be present in firm bottom deep pools or along margins of some stream reaches; however, this occurrence is very infrequent.
- Have low to moderate gradient landscapes. Undisturbed portions of the floodplain may tend toward wetland characteristics.

There will be situations where riffle/run streams tend towards glide/pool or where glide/pool streams tend toward riffle/run. If the stream type is unclear, visually survey an expanded length of stream channel, noting the dominant substrate and flow characteristics. If the stream type remains unclear, complete both *Riffle/Run* and *Glide/Pool* habitat field forms. (Note: Riffle/Run channels that tend towards glide/pool or glide/pool channels that approach riffle/run conditions generally score nearly identically.) If there is reasonable agreement between the 2 forms, record an average of the 2 scores.

There will be occasions when the existing conditions do not fit 1 or more of the metrics given. In such cases, score each metric as close as possible and note the condition(s) that deviates from the expected, along with any needed explanation for your final score.

A. Procedure for Performing Habitat Assessment

The habitat assessment should be performed on a sufficient length of stream that reflects the typical habitat conditions associated with the biological sampling results. At a minimum, this reach should be no less than the section of stream used for biological sampling. Some parameters require an observation of a broader section of the watershed than the biological sampling reach alone and may require traversing the stream corridor to the extent deemed necessary to assess the habitat feature. As a general rule-of-thumb, use 2 lengths of the biological sampling reach to assess these parameters. If there is a team of 2 or more biologists, come to a consensus for each metric.

This policy provides guidance to staff regarding the implementation and interpretation of laws administered by the DEQ. It is merely explanatory, does not affect the rights of or procedures and practices available to the public, and it does not have the force and effect of law.

WATER BUREAU POLICY AND PROCEDURES

NUMBER:	WB-SWAS-051	
SUBJECT:	QUALITATIVE BIOLOGICAL AND HABITAT SURVEY PROTOCOLS FOR WADEABLE STREAMS AND RIVERS	
EFFECTIVE DATE:	1990, REVISED 1991, 1997, 2002	PAGE: 15 of 53
REVISION DATE:	NOVEMBER 2008	

Metric 1 EPIFAUNAL SUBSTRATE/AVAILABLE COVER *Riffle/Run and Glide/Pool Streams*

This metric includes the relative quantity and variety of natural structures in the stream, such as cobble (riffles), large rocks, fallen trees, logs and branches, and undercut banks, available as refugia, feeding, or sites for spawning and nursery functions of aquatic macrofauna. A wide variety and/or abundance of submerged structures in the stream provide macroinvertebrates and fish with a large number of niches, thus increasing habitat diversity. As variety and abundance of cover decreases, habitat structure becomes monotonous, diversity decreases, and the potential for recovery following disturbance decreases. Riffles and runs are critical for maintaining a variety and abundance of insects in most riffle/run streams and serving as spawning and feeding refugia for certain fish. The extent and quality of the riffle is an important factor in the support of a healthy biological condition in riffle/run streams. Riffles and runs offer a diversity of habitat through variety of particle size and, in many small high-gradient streams, will provide the most stable habitat. Snags and submerged logs are among the most productive habitat structure for macroinvertebrate colonization and fish refugia in glide/pool streams. However, "new fall" will not yet be suitable for colonization.

Assess both *Riffle/Run* and *Glide/Pool* streams by estimating the amount of stream channel in the sample reach that contains substrates that are free from sedimentation or siltation impacts and favorable for epifaunal colonization. Materials that are easily moved or displaced (silts, sand, and fine gravels) or unstable vegetation, such as bank grass or small stemmed brush tops, are not considered as stable. Some of the larger varieties of vascular aquatic macrophytes may be considered as a stable substrate; however, woody debris that is free-floating in back eddy's or temporarily trapped along stream margins should not be considered as a stable substrate.

Habitat Parameter	Condition Category			
	Excellent	Good	Marginal	Poor
1. Epifaunal Substrate/ Available Cover (Riffle/Run and Glide/Pool)	Greater than 70% (50% for glide/pool streams) of substrate are free from sedimentation/siltation and favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/ snags that are <u>not</u> new fall and <u>not</u> transient).	40-70% (30-50% for glide/pool streams) mix of stable habitat; free from sedimentation/siltation and well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% (10-30% for glide/pool streams) mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed, removed, or covered by sediment/silt.	Less than 20% (10% for glide/pool streams) stable habitat; lack of habitat is obvious; substrate unstable or lacking.
SCORE	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Metric 2a EMBEDDEDNESS *Riffle/Run Streams*

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WATER BUREAU POLICY AND PROCEDURES

NUMBER: WB-SWAS-051
SUBJECT: QUALITATIVE BIOLOGICAL AND HABITAT SURVEY PROTOCOLS FOR WADEABLE STREAMS AND RIVERS
EFFECTIVE DATE: 1990, REVISED 1991, 1997, 2002
REVISION DATE: NOVEMBER 2008

PAGE: 16 of 53

This metric refers to the extent to which rocks (gravel, cobble, and boulders) and snags are covered or sunken into the silt, sand, or mud of the stream bottom. Generally, as rocks become embedded, the surface area available to macroinvertebrates and fish (shelter, spawning, and egg incubation) is decreased. Embeddedness is a result of large-scale sediment movement and deposition and is a parameter evaluated in the riffles and runs of high-gradient streams.

The rating of this parameter may be variable depending on where the observations are taken. To avoid confusion with sediment deposition (another habitat parameter), observations of embeddedness should be taken in the upstream and central portions of riffles and cobble substrate areas. Grasp and remove several cobbles at the sediment/water interface and estimate an average depth that is into the sediment.

Habitat Parameter	Condition Category																				
	Excellent					Good					Marginal					Poor					
2.a Embeddedness (Riffle/Run Stream)	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.					Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.					Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.					Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.					
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Metric 2b POOL SUBSTRATE CHARACTERIZATION *Glide/Pool Streams*

This metric evaluates the type and condition of bottom substrates found in pools. Firmer sediment types (e.g., gravel and sand) and rooted aquatic plants support a wider variety of organisms than a pool substrate dominated by mud or bedrock and no plants. In addition, a stream that has a uniform substrate in its pools will support far fewer types of organisms than a stream that has a variety of substrate types. *Glide/Pool* systems should be assessed by visual observations and, where possible, prodding with a net handle or wading staff, or simply wading slowly and carefully through the pool area itself.

Habitat Parameter	Condition Category																				
	Excellent					Good					Marginal					Poor					
2b. Pool Substrate Characterization (Glide/Pool)	Mixture of substrate materials, with gravel and firm sand prevalent; root mats and submerged vegetation common.					Mixture of soft sand, mud, or clay; mud may be dominant; some root mats and submerged vegetation present.					All mud or clay or sand bottom; little or no root mat; no submerged vegetation.					Hard-pan clay or bedrock; no root mat or submerged vegetation.					
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Metric 3a VELOCITY/DEPTH COMBINATIONS *Riffle/Run Streams*

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WATER BUREAU POLICY AND PROCEDURES

NUMBER: WB-SWAS-051
SUBJECT: QUALITATIVE BIOLOGICAL AND HABITAT SURVEY PROTOCOLS FOR WADEABLE STREAMS AND RIVERS
EFFECTIVE DATE: 1990, REVISED 1991, 1997, 2002
REVISION DATE: NOVEMBER 2008

PAGE: 17 of 53

Patterns of velocity and depth are included for riffle/run streams under this parameter as an important feature of habitat diversity. The best streams in most riffle/run regions will have all 4 patterns present: (1) slow-deep, (2) slow-shallow, (3) fast-deep, and (4) fast-shallow. The general guidelines are 1.5 feet depth to separate shallow from deep, and 1.0 foot per second (f/s) to separate fast from slow. The occurrence of these 4 patterns relates to the stream's ability to provide and maintain a stable aquatic environment and is expected to vary with stream size and watershed characteristics.

Both depth and velocity are relative to stream size. A deep pool in a stream that is 3 feet wide may be no more than 10-12 inches yet 4-6 feet deep in a river that is 80 feet or more wide. In a similar fashion, a flow velocity of 0.7 f/s may be considered to be fast in very small streams yet slow in larger systems.

Habitat Parameter	Condition Category																				
	Excellent					Good					Marginal					Poor					
3a. Velocity/ Depth Regimes (Riffle/Run)	All 4 velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow). (slow is <1.0 f/s, deep is >1.5 ft.)					Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).					Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).					Dominated by 1 velocity/ depth regime (usually slow-deep).					
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Metric 3b POOL VARIABILITY *Glide/Pool Streams*

This metric rates the overall mixture of pool types found in streams, according to size and depth. The 4 basic types of pools are large-shallow, large-deep, small-shallow, and small-deep. A stream with many pool types will support a wide variety of aquatic species. Rivers with low sinuosity (few bends) and monotonous pool characteristics do not have sufficient quantities and types of habitat to support a diverse aquatic community. General guidelines are any pool dimension (i.e., length, width, and depth) greater than half the cross-section of the stream for separating large from small and 3 feet depth separating shallow and deep. However, the size (width) of the stream channel will have a direct consequence on the relative relationship between pool sizes (see description of expected variation in stream velocity/depth assessment above).

Habitat Parameter	Condition Category																				
	Excellent					Good					Marginal					Poor					
3b. Pool Variability (Glide Pool)	Even mix of large-shallow, large-deep, small-shallow, small-deep pools present.					Majority of pools large-deep; very few shallow.					Shallow pools much more prevalent than deep pools.					Majority of pools small-shallow or pools absent.					
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Metric 4 SEDIMENT DEPOSITION *Riffle/Run and Glide/Pool Streams*

This metric estimates the amount of sediment that has accumulated in pools and the changes that have occurred to the stream bottom as a result of deposition. Deposition occurs from large-scale

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WATER BUREAU POLICY AND PROCEDURES

NUMBER: WB-SWAS-051
SUBJECT: QUALITATIVE BIOLOGICAL AND HABITAT SURVEY PROTOCOLS FOR WADEABLE STREAMS AND RIVERS
EFFECTIVE DATE: 1990, REVISED 1991, 1997, 2002
REVISION DATE: NOVEMBER 2008

PAGE: 18 of 53

movement of sediment. Sediment deposition may cause the formation of islands, point bars (areas of increased deposition usually at the beginning of a meander that increases in size as the channel is diverted toward the outer bank) or shoals, or result in the filling of runs and pools. Usually deposition is evident in areas that are obstructed by natural or man-made debris and areas where the stream flow decreases, such as bends. High levels of sediment deposition are symptoms of an unstable and continually changing environment that becomes unsuitable for many organisms.

Habitat Parameter	Condition Category																				
	Excellent					Good					Marginal					Poor					
4. Sediment Deposition (Riffle/Run and Glide /Pool Streams)	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.					Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for glide/pool) of the bottom affected; slight deposition in pools.					Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for glide/pool) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.					Heavy deposits of fine material, increased bar development; more than 50% (80% for glide/pool) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.					
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Metric 5 CHANNEL FLOW STATUS *Riffle/Run and Glide/Pool Streams*

The degree to which stream flow is maintained in the channel (5a) and the speed and magnitude of flow response to rain events (flashiness) (5b) collectively describes the channel flow status of the stream. The flow status will change as the channel enlarges (e.g., aggrading streambeds with actively widening channels), as a result of dams and other obstructions, diversions for irrigation, drought, increases in the amount of impervious surfaces in the watershed, or enhanced drainage to support agricultural land use. Channel flow can be especially useful for interpreting biological conditions under abnormal or lowered flow conditions, with indications of significant flow instability relatively easy to see in a stream at or near base flow conditions.

The amount of suitable substrates for aquatic organisms becomes limited when stream flow is not maintained at adequate levels. In both riffle/run and glide/pool streams, bottom substrates can become exposed, reducing good habitat areas for fish and macroinvertebrate communities. Estimating insufficient flows due to water loss can be done by looking for exposed river substrate materials along the lateral portions of the wetted channel, dried algae or fine sediment deposits on rocks, or large woody debris (LWD) above and adjacent to the waterline.

An increased response to precipitation events is called flashiness and is often correlated with a decrease in stream habitat. Flashy streams are most often impaired by excessive erosive energy that destabilizes and impairs habitat that is otherwise suitable for colonization by aquatic organisms. In stable streams, LWD, where available, can be found throughout the wetted portion of the channel, often perpendicular to the direction of flow. Streambank vegetation typically exists at or near the water/streambank interface. In flashy systems, woody debris is generally flushed from the thalweg

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WATER BUREAU POLICY AND PROCEDURES

NUMBER: WB-SWAS-051
SUBJECT: QUALITATIVE BIOLOGICAL AND HABITAT SURVEY PROTOCOLS FOR WADEABLE STREAMS AND RIVERS
EFFECTIVE DATE: 1990, REVISED 1991, 1997, 2002
REVISION DATE: NOVEMBER 2008

PAGE: 19 of 53

toward the stream banks or is removed from the active channel entirely. Streambank vegetation is removed above normal flow levels by frequent high water events.

An estimation of stream flashiness is made by observing the vegetation density at the water/streambank interface, and, where applicable, the position of LWD and LWD jams in the stream channel. However, the difference between scoured banks and areas where streambank soils may naturally produce a poorly vegetated zone along the water-streambank interface must be recognized. Some soil types near the water's edge are continually saturated and may normally be void of vegetation. In addition, some dense clay soils may take a relatively long time to revegetate following a disturbance, resulting in a false appearance of scouring from frequent high flows. Conversations with people living near the stream can be used to corroborate observations regarding stream flashiness or the ability of the stream to maintain sufficient base flow levels.

Habitat Parameter	Condition Category											
	Excellent			Good			Marginal			Poor		
5a. Channel Flow Status – Maintained Flow Volume (Riffle/Run and Glide/Pool Streams)	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.			Water fills >75% of the available channel; or <25% of channel substrate is exposed.			Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.			Very little water in channel and mostly present as standing pools.		
SCORE	10	9		8	7	6	5	4	3	2	1	0

Habitat Parameter	Condition Category											
	Excellent			Good			Marginal			Poor		
5b. Channel Flow Status - Flashiness (Riffle/Run and Glide/Pool Streams)	Vegetation along the stream banks is complete nearly to the waters edge. Little or no evidence of frequent changes in discharge and/or frequent high water events that scour streambank vegetation. Large woody debris (if present) stable and extending laterally across the stream channel.			Some evidence of bank scour approximately 4-8 inches above the waters surface. Large woody debris (if present) mostly stable and extending partially into the active stream channel			Bank scour evident 9-18 inches above the waters surface. Large woody debris (if present) tend to lay more against the streambank rather than extending into the active channel.			Bank scour severe (>20 inches) along the stream channel. Large woody debris is generally absent from the active channel and/or may exist as woody debris jams along the streambank above the active channel.		
SCORE	10	9		8	7	6	5	4	3	2	1	0

Metric 6 CHANNEL ALTERATION *Riffle/Run and Glide/Pool Streams*

This metric is a measure of large-scale changes in the shape of the stream channel. Many streams in urban and agricultural areas have been straightened, deepened, or diverted into concrete channels, often for flood control or irrigation purposes. Such streams have far fewer natural habitats for fish, macroinvertebrates, and plants than do naturally meandering streams. Channel alteration is present

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**WATER BUREAU
POLICY AND PROCEDURES**

NUMBER: WB-SWAS-051
SUBJECT: QUALITATIVE BIOLOGICAL AND HABITAT SURVEY PROTOCOLS FOR WADEABLE STREAMS AND RIVERS
EFFECTIVE DATE: 1990, REVISED 1991, 1997, 2002 **PAGE:** 20 of 53
REVISION DATE: NOVEMBER 2008

when artificial embankments, riprap, and other forms of artificial bank stabilization or structures are present; when the stream is very straight for significant distances; and when dams and bridges are present. Scouring is often associated with channel alteration, as is a reduction in flow velocity during base flow conditions.

Minimal channel alterations may include short channel sections that have been modified to facilitate road/stream crossings. Estimate and record the length of river/stream/drain that has been recently channelized (within the last 5-10 years) and/or has evidence of actively or somewhat actively maintained stream banks.

Habitat Parameter	Condition Category																				
	Excellent					Good					Marginal					Poor					
6. Channel Alteration (Riffle/Run and Glide/Pool Streams)	Channelization or dredging absent or minimal; stream with normal pattern.					Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.					Channelization is continuous but not recent (> 5 years); embankments without mature trees and dominated by grasses and shrubs.					Stream reach has been recently channelized (<5 years). OR Banks shored with gabion, rock, cement or bare earth. Instream habitat greatly altered or removed entirely. Bank vegetation moderately dense to absent					
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Metric 7a FREQUENCY OF RIFFLES (OR BENDS) *Riffle/Run Streams*

This metric measures the sequence of riffles and thus the heterogeneity occurring in a stream. Riffles are a source of high-quality habitat and diverse fauna; therefore, an increased frequency of occurrence greatly enhances the diversity of the stream community.

Measuring the sequencing pattern of the stream is necessary to rate this metric. Estimate the frequency of riffles (or bends) by simply measuring the distance between each occurrence. For riffle/run streams where distinct riffles are uncommon, a run/bend ratio can be used as a measure of meandering or sinuosity (see Metric 7b). To gain an appreciation of this metric in some streams, a longer segment or reach than that designated for sampling should be incorporated into the evaluation. In some situations (i.e., larger rivers), this metric may be rated from viewing topographical maps.

Habitat Parameter	Condition Category																			
	Excellent					Good					Marginal					Poor				
7a. Frequency of Riffles (or bends) (Riffle/Run Stream)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety					Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 and 15.					Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between					Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.				

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**WATER BUREAU
POLICY AND PROCEDURES**

NUMBER: WB-SWAS-051
SUBJECT: QUALITATIVE BIOLOGICAL AND HABITAT SURVEY PROTOCOLS FOR WADEABLE STREAMS AND RIVERS
EFFECTIVE DATE: 1990, REVISED 1991, 1997, 2002
REVISION DATE: NOVEMBER 2008

PAGE: 21 of 53

Habitat Parameter	Condition Category																				
	Excellent					Good					Marginal					Poor					
	of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.										15 and 25.										
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Metric 7b CHANNEL SINUOSITY *Glide/Pool Streams*

This metric evaluates the meandering or sinuosity of the stream. A high degree of sinuosity provides for diverse habitat and fauna. The absorption of flow energy by bends protects the stream from excessive erosion and flooding and provides refugia for macroinvertebrates and fish during runoff events.

Measuring the sequencing pattern of the stream is necessary to rate this metric. Channel sinuosity can be estimated by dividing a channel length that includes 2 stream bends by the straight line distance between these 2 points. In some situations (i.e., large rivers), this metric may be rated from viewing topographical maps. To gain an appreciation of this metric in glide/pool streams, a longer segment or reach than that designated for sampling may be incorporated into the evaluation.

Habitat Parameter	Condition Category																				
	Excellent					Good					Marginal					Poor					
7b. Channel	The bends in the stream increase the stream length 3 to 4 times longer than if it was in a straight line. (Note - channel braiding is considered normal in coastal plains and other low-lying areas. This parameter is not easily rated in these areas.)					The bends in the stream increase the stream length 2 to 3 times longer than if it was in a straight line.					The bends in the stream increase the stream length 1 to 2 times longer than if it was in a straight line. (Note: lack of sinuosity may be due to channelization)					Channel straight; waterway has been channelized for a long distance.					
+Sinuosity																					
(Glide/Pool Stream)																					
SCORE	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Metric 8 BANK STABILITY (condition of banks) *Riffle/Run and Glide/Pool Streams*

This metric measures whether the stream banks are eroded (or have the potential for erosion). Steep banks are more likely to collapse and suffer from erosion than are gently sloping banks and are, therefore, considered to be unstable. Signs of erosion include crumbling, unvegetated banks, exposed tree roots, and exposed soil. Eroded banks indicate a problem of soil movement into the

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**WATER BUREAU
POLICY AND PROCEDURES**

NUMBER: WB-SWAS-051
SUBJECT: QUALITATIVE BIOLOGICAL AND HABITAT SURVEY PROTOCOLS FOR WADEABLE STREAMS AND RIVERS
EFFECTIVE DATE: 1990, REVISED 1991, 1997, 2002
REVISION DATE: NOVEMBER 2008

PAGE: 22 of 53

stream and suggest a scarcity of streambank cover and organic input to the stream. Each bank is evaluated separately and the cumulative score (right and left) is used for this parameter.

Habitat Parameter	Condition Category											
	Excellent			Good			Marginal			Poor		
8. Bank Stability (score each bank) <u>Note: determine left or right side by facing downstream</u> (Riffle/Run and Glide/Pool Streams)	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for problems. <5% of bank affected.			Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.			Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.			Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.		
SCORE ____ (LB)	Left Bank	10	9	8	7	6	5	4	3	2	1	0
SCORE ____ (RB)	Right Bank	10	9	8	7	6	5	4	3	2	1	0

Metric 9 BANK VEGETATIVE PROTECTION *Riffle/Run and Glide/Pool Streams*

This metric evaluates the degree of vegetative protection afforded to the streambank and the near-stream portion of the riparian zone. The root systems of plants growing on stream banks help hold soil in place, thereby reducing the amount of erosion that is likely to occur. This metric supplies information on the ability of the bank to resist erosion, as well as some additional information on the uptake of nutrients by the plants, the control of instream scouring, and stream shading. Banks that have full, natural plant growth are better for fish and macroinvertebrates than are banks without vegetative protection or those shored up with concrete or riprap. Wetland stream banks (e.g., marsh or swamp) will be dramatically different than the typical climax forest community but are equally protective to the physical and biological community. In contrast, dense monocultures of exotic plant species (i.e., purple loosestrife) do not offer the same degree of protection as a diverse community of native vegetation and should be scored accordingly. In areas of high grazing pressure from livestock or where residential and urban development activities disrupt the riparian zone, the growth of a natural plant community is impeded and can extend to the bank vegetative protection zone.

For this metric, consider the bank condition between the aquatic/terrestrial interface to a point immediately past the streambank/riparian zone interface. Each bank is evaluated separately and the cumulative score (right and left) is used for this parameter.

Habitat Parameter	Condition Category			
	Excellent	Good	Marginal	Poor
9. Vegetative Protection (score each)	More than 90% of the streambank surfaces and immediate riparian zones covered by	70-90% of the streambank surfaces covered by vegetation, but 1 class of plants is	50-70% of the streambank surfaces covered by vegetation; disruption obvious;	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank

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WATER BUREAU POLICY AND PROCEDURES

NUMBER: WB-SWAS-051
SUBJECT: QUALITATIVE BIOLOGICAL AND HABITAT SURVEY PROTOCOLS FOR WADEABLE STREAMS AND RIVERS
EFFECTIVE DATE: 1990, REVISED 1991, 1997, 2002
REVISION DATE: NOVEMBER 2008

PAGE: 23 of 53

Habitat Parameter	Condition Category											
	Excellent			Good			Marginal			Poor		
(bank) <u>Note: determine left or right side by facing downstream.</u> (Riffle/Run and Glide/Pool Streams)	vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.			not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.			patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.			vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.		
SCORE ____ (LB)	Left Bank	10	9	8	7	6	5	4	3	2	1	0
SCORE ____ (RB)	Right Bank	10	9	8	7	6	5	4	3	2	1	0

Metric 10 RIPARIAN VEGETATIVE ZONE WIDTH *Riffle/Run and Glide/Pool Streams*

This metric measures the width of natural vegetation from the edge of the streambank out through the riparian zone. The riparian zone prevents a wide range of pollutants from entering a stream from runoff and provides erosion control. In addition, a diverse riparian zone plays an active role in water quality by providing a continuous source of materials and shade that act to stabilize both the physical and biological aspects of the stream environment. A relatively undisturbed riparian zone that has an adequate width will support a robust stream system. Narrow riparian zones occur when roads, parking lots, fields, lawns, bare soil, rocks, or buildings are near the streambank. Residential developments, urban centers, golf courses, and agricultural land uses are the common causes of anthropogenic degradation of the riparian zone. Conversely, the presence of "old field" (i.e., a previously developed field not currently in use), paths, and walkways in an otherwise undisturbed riparian zone may be judged to be inconsequential to altering the riparian zone and may be given relatively high scores.

The ability of the riparian zone to protect aquatic environs is based on the collective function of a diverse plant community, water storage capabilities, and to a certain extent, stream width. Therefore, consider the diversity of vegetation, as well as the width of the riparian zone. Grass filter strips, lawns, or lush stream banks are not considered to be part of the riparian zone because they do not offer a significant resource to the physical or biological community. Old field land use, depending on the point of transition between agriculture and a climax riparian community, will offer some to most of the potential resource to the stream. A fully functional riparian zone contains diverse vegetation, including trees, understory shrubs, and nonwoody macrophytes. Small streams (approximately 10 feet wide or less) accompanied by diverse riparian widths of less than 150 feet may be considered as excellent. Wetland riparian zones (e.g., marsh or swamp) will be dramatically different than the typical climax forest community but are equally protective to the physical and biological community.

Habitat Parameter	Condition Category			
	Excellent	Good	Marginal	Poor

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WATER BUREAU POLICY AND PROCEDURES

NUMBER: WB-SWAS-051
SUBJECT: QUALITATIVE BIOLOGICAL AND HABITAT SURVEY PROTOCOLS FOR WADEABLE STREAMS AND RIVERS
EFFECTIVE DATE: 1990, REVISED 1991, 1997, 2002
REVISION DATE: NOVEMBER 2008

PAGE: 24 of 53

Habitat Parameter	Condition Category											
	Excellent			Good			Marginal			Poor		
10. Riparian Vegetative Zone Width (score each bank riparian zone) (Riffle/Run and Glide/Pool Streams)	Width of riparian zone >150 feet; dominated by vegetation, including trees, understory shrubs, or nonwoody macrophytes or wetlands; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally. Human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.			Width of riparian zone 75-150 feet; human activities have impacted zone only minimally.			Width of riparian zone 10-75 feet; human activities have impacted the composition of the vegetation a great deal.			Width of riparian zone <10 feet: little or no riparian vegetation due to human activities.		
SCORE ____ (LB)	Left Bank	10	9	8	7	6	5	4	3	2	1	0
SCORE ____ (RB)	Right Bank	10	9	8	7	6	5	4	3	2	1	0

VIII. OVERALL APPLICATION AND INTEGRATION

A. Relationship of Habitat Quality and Biological Condition

The optimum biological community stability and biological diversity of a site for both fish and macroinvertebrates may be determined by the quality of the habitat at that site. Excellent habitat will allow for high quality biological communities. Community responses to minor alteration in habitat are often subtle. As habitat quality continues to decline, however, recognizable and measurable biological changes (impairments) occur. These changes, in the absence of confounding water quality effects, are generally in direct proportion to the degree of habitat change. When habitat becomes severely degraded, changes in the biological communities become harder to recognize and measure. The biological communities existing under these degraded habitat conditions are represented by opportunistic species, which are more tolerant of such habitat perturbations and often insensitive to further habitat degradation. This may result in a poor habitat characterization corresponding to either a moderately or severely impacted biological community depending on the specific site and situation.

In areas of good or excellent habitat, biological communities will reflect degraded conditions when adverse water quality effects exist. As habitat degrades further in the continued presence of water quality problems, such as chemical toxicants or nutrient enrichment, the biological communities may show less dramatic changes as each community becomes dominated by tolerant and opportunistic species.

IX. QUALITY ASSURANCE/QUALITY CONTROL

As with any scientific study, quality must be assured and tested before the results can be accepted. Quality assurance is accomplished through use of professional and trained biologists, establishment

This policy provides guidance to staff regarding the implementation and interpretation of laws administered by the DEQ. It is merely explanatory, does not affect the rights of or procedures and practices available to the public, and it does not have the force and effect of law.

Appendix C:
Invertebrate Community Data
Grab Samples

Appendix C. Benthic Invertebrate Community Data - Grab Samples:
Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	CR-Ref-01-IC-SBA	CR-Ref-01-IC-SBB	CR-Ref-01-IC-SBC	CR-Ref-02-IC-SBA	CR-Ref-02-IC-SBB	CR-Ref-02-IC-SBC	RB-013+50-SBA	RB-013+50-SBB	RB-013+50-SBC	RB-013-00-IC-SBA	RB-013-00-IC-SBB	RB-013-00-IC-SBC	RE-077-50-IC-SBA	RE-077-50-IC-SBB	RE-077-50-IC-SBC	RG-128-50-IC-SBA
Nematoda			round worm	PA	9	8								1			1	1	1	4	2
Tricladida	Planariidae	<i>Dugesia tigrina</i>	flat worm	PR	6												1				
Hoplonemertea	Tetrastemmatidae	<i>Prostoma graecense</i>	proboscis worm	PR	8	1			1			1									4
Hirudinea	Glossiphoniidae	<i>Helobdella elongata</i>	leech	PR	8																
Hirudinea	Glossiphoniidae	<i>Helobdella stagnalis</i>	leech	PR	8																
Tubificida	Naididae	<i>Dero obtusa</i>	naiad worm	GC	10																
Tubificida	Naididae	<i>Nais bretscheri</i>	naiad worm	GC	6															48	
Tubificida	Naididae	<i>Nais sp.</i>	naiad worm	GC	8	4			36	30	15	36	4		29	9	72	11	27	48	32
Tubificida	Enchytraeidae		aquatic worm	GC	10																
Tubificida	Tubificidae	<i>Branchiura sowerbyi</i>	tube worm	GC	6						1					1	8		9	8	
Tubificida	Tubificidae	<i>Limnodrilus hoffmeisteri</i>	tube worm	GC	10												2				
Tubificida	Tubificidae	<i>Limnodrilus sp.</i>	tube worm	GC	10						1		13	7		11	4		2	8	1
Basommatophora	Ancylidae	<i>Ferrissia rivularis</i>	limpet snail	SC	7						1		1		7	3	1	6	12	3	1
Basommatophora	Lymnaeidae	<i>Fossaria sp.</i>	pond snail	SC	2.6								1	3							
Basommatophora	Physidae	<i>Physa sp.</i>	pouch snail	SC	9								1	3	1	3		1			
Basommatophora	Planorbidae	<i>Gyraulus parvus</i>	ram's horn snail	SC	5.5																
Basommatophora	Planorbidae	<i>Helisoma sp.</i>	ram's horn snail	SC	7											2					
Basommatophora	Hydrobiidae	<i>Amnicola sp.</i>	dusky snail	SC	4															1	
Mesogastropoda	Pleuroceridae	<i>Goniobasis livescens</i>	horn snail	SC	6													2			
Mesogastropoda	Pleuroceridae	<i>Leptoxis carinata</i>	horn snail	SC	6													1			
Veneroida	Dreissenidae	<i>Dreissena polymorpha</i>	zebra mussel	FC	8										16	21	3	4	6	10	1
Veneroida	Sphaeriidae	<i>Pisidium sp.</i>	pill clam	FC	4.6						2		8	14		1		1			
Hydracarina			water mite	PR	6	2					1										
Amphipoda	Gammaridae	<i>Gammarus fasciatus</i>	sideswimmer	GC	3			1			3		1		2	11	31				
Amphipoda	Hyalellidae	<i>Hyalella azteca</i>	sideswimmer	GC	8								2			2	5	7		1	
Decapoda	Cambaridae	<i>Orconectes sp.</i>	crayfish	GC	5																
Isopoda	Asellidae	<i>Caecidotea sp.</i>	sowbug	GC	6											4	2	3			
Ephemeroptera	Baetidae	<i>Acerpenna sp.</i>	mayfly	SH	4					1											
Ephemeroptera	Baetidae	<i>Baetis sp.</i>	mayfly	GC	3.1	2								1							
Ephemeroptera	Baetidae	<i>Centroptilum sp.</i>	mayfly	GC	2				5	8	4	5	2								
Ephemeroptera	Baetidae	<i>Plauditus sp.</i>	mayfly	GC	4	35	4	20													
Ephemeroptera	Baetiscidae	<i>Baetisca sp.</i>	mayfly	GC	4	9			6	8	32	6	1	1	1	4	1	1			
Ephemeroptera	Caenidae	<i>Caenis sp.</i>	mayfly	GC	7					1	2				2	2	3	6		1	1
Ephemeroptera	Ephemeridae	<i>Ephemer a sp.</i>	mayfly	CG	1											1				1	
Ephemeroptera	Hexageniidae	<i>Hexagenia sp.</i>	mayfly	GC	6								1								
Ephemeroptera	Heptageniidae	<i>Maccaffertium mediopunctatur.</i>	mayfly	SC	3																
Ephemeroptera	Heptageniidae	<i>Maccaffertium sp.</i>	mayfly	SC	4	5					1				1	9		2		3	
Ephemeroptera	Heptageniidae	<i>Stenacron interpunctatum</i>	mayfly	OM	7	1									9	16	10		3		
Ephemeroptera	Heptageniidae	<i>Stenonema femoratur.</i>	mayfly	OM	5																
Ephemeroptera	Isonychiidae	<i>Isonychia sp.</i>	mayfly	FC	2																
Ephemeroptera	Leptophlebiidae	<i>Paraleptophlebia sp.</i>	mayfly	GC	1					1	1				7	13	1	6	5	5	
Ephemeroptera	Potamanthidae	<i>Anthopotamus verticis gr.</i>	mayfly	GC	3.2				5	7	21	5			2	3	2	32	4	8	
Ephemeroptera	Tricorythidae	<i>Tricorythodes sp.</i>	mayfly	GC	4	47	1	4	3		3	3			3	6		2	4	3	1
Odonata	Calopterygidae	<i>Haeterina sp.</i>	damselfly	PR	6													1		1	
Odonata	Coenagrionidae	<i>Argia sp.</i>	damselfly	PR	5.1											9	2		2	2	
Odonata	Coenagrionidae	<i>Enallagma sp.</i>	damselfly	PR	9				1			1			3	1	3		6	3	
Odonata	Corduliidae	<i>Neurocordulia sp.</i>	dragonfly	PR	3											1					
Odonata	Gomphidae		dragonfly	PR	4										1	1					
Odonata	Gomphidae	<i>Gomphus sp.</i>	dragonfly	PR	5																
Plecoptera	Taeniopterygidae	<i>Taeniopteryx sp.</i>	stonefly	SH	2	2		1							2	2			7		
Megaloptera	Sialidae	<i>Sialis sp.</i>	alderfly	PR	4																
Hemiptera	Corixidae	<i>Sigara lineata</i>	water boatmen	GC	8				3	13	14	3	37	13							
Trichoptera	Brachycentridae	<i>Brachycentrus sp.</i>	caddisfly	FC	1	1	1	16											2	1	
Trichoptera	Glossosomatidae	<i>Protoptila sp.</i>	caddisfly	SC	1	1	2														
Trichoptera	Helicopsychidae	<i>Helicopsyche borealis</i>	caddisfly	SC	3			1								1					
Trichoptera	Hydropsychidae	<i>Cheumatopsyche sp.</i>	caddisfly	FC	5	8	3	6		1								3		2	3
Trichoptera	Hydropsychidae	<i>Hydropsyche aerata</i>	caddisfly	FC	2.6		2	4										1			
Trichoptera	Hydropsychidae	<i>Hydropsyche morosa</i>	caddisfly	FC	2																
Trichoptera	Hydropsychidae	<i>Hydropsyche phalerata</i>	caddisfly	FC	1	22	12	98										6	2		
Trichoptera	Hydropsychidae	<i>Hydropsyche sparna</i>	caddisfly	FC	1																
Trichoptera	Hydropsychidae	<i>Hydropsyche sp.</i>	caddisfly	FC	5	12	3	24			1	3			2		1	30	27	2	4
Trichoptera	Hydroptilidae	<i>Hydroptilia sp.</i>	caddisfly	PR	6						3				1		2	1	1	1	
Trichoptera	Lepidostomatidae	<i>Lepidostoma sp.</i>	caddisfly	SH	1												1				
Trichoptera	Leptoceridae	<i>Nectopsyche sp.</i>	caddisfly	SH	2.4	1				1		1									
Trichoptera	Leptoceridae	<i>Oecetis sp.</i>	caddisfly	PR	8	1				1		3	1	1		1	3			1	
Trichoptera	Leptoceridae	<i>Triaenodes sp.</i>	caddisfly	SH	3														1		
Trichoptera	Polycentropodidae	<i>Cymellus fraternus</i>	caddisfly	FC	8											1					
Trichoptera	Polycentropodidae	<i>Neureclipsis sp.</i>	caddisfly	FC	7													1			
Trichoptera	Polycentropodidae	<i>Polycentropus sp.</i>	caddisfly	PR	6										1	4	3				
Trichoptera	Uenoidae	<i>Neophylax sp.</i>	caddisfly	SC	3															1	
Lepidoptera	Pyrilidae	<i>Parapoynx sp.</i>	moth	SH	5			1						1	1			2	1	3	
Lepidoptera	Pyrilidae	<i>Petrophila sp.</i>	moth	SC	2.7	1															2
Coleoptera	Elmidae	<i>Dubiraphia vittata</i>	riffle beetle	OM	7				10	5	5	10	3	4	4		6	7		2	3
Coleoptera	Elmidae	<i>Macronychus glabratus</i>	riffle beetle	OM	4	1									2		1				1
Coleoptera	Elmidae	<i>Optioservus sp.</i>	riffle beetle	SC	4	9	1														
Coleoptera	Elmidae	<i>Stenelmis crenata gr.</i>	riffle beetle	SC	5	2	1				2					4		5	4	4	2
Coleoptera	Gyrinidae	<i>Dineutus sp.</i>	whirligig beetle	PR	3.7																
Coleoptera	Hydrophilidae	<i>Berosus sp.</i>	scavenger beetle	PR	6.7											1					
Coleoptera	Psephenidae	<i>Ectopria nervosus</i>	false water penny	SC	5											21					
Coleoptera	Psephenidae	<i>Psephenus herricki</i>	water penny	SC	4																
Diptera	Athericidae	<i>Atherix sp.</i>	watersnipe fly	PR	4																
Diptera	Ceratopogonidae	<i>Palpomyia gr.</i>	biting midge	PR	6	1															
Diptera	Ceratopogonidae	<i>Probezzia sp.</i>	biting midge	PR	6									2							

Appendix C. Benthic Invertebrate Community Data - Grab Samples: Data and Metric Calculations																						
Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	CR-Ref-01-IC-SBA	CR-Ref-01-IC-SBB	CR-Ref-01-IC-SBC	CR-Ref-02-IC-SBA	CR-Ref-02-IC-SBB	CR-Ref-02-IC-SBC	RB-013+50-SBA	RB-013+50-SBB	RB-013+50-SBC	RB-013-00-IC-SBA	RB-013-00-IC-SBB	RB-013-00-IC-SBC	RE-077-50-IC-SBA	RE-077-50-IC-SBB	RE-077-50-IC-SBC	RG-128-50-IC-SBA	
Diptera	Chironomidae	<i>Ablabesmyia janta</i>	midge	OM	4.9									2	5		6					
Diptera	Chironomidae	<i>Ablabesmyia mallochi</i>	midge	OM	8											5						
Diptera	Chironomidae	<i>Chironomini</i>	midge	GC	6		1				1											
Diptera	Chironomidae	<i>Chironomus sp.</i>	midge	GC	10				1		1	1		8					4		4	
Diptera	Chironomidae	<i>Cladotanytarsus sp.</i>	midge	GC	7									2							4	
Diptera	Chironomidae	<i>Corynoneura sp.</i>	midge	GC	7											4	8	8		4		
Diptera	Chironomidae	<i>Cricotopus bicintus</i>	midge	OM	6.7											2				100		
Diptera	Chironomidae	<i>Cricotopus sp.</i>	midge	SH	7																	
Diptera	Chironomidae	<i>Cricotopus trifasciata</i>	midge	OM	7																	
Diptera	Chironomidae	<i>Cryptochironomus fulvus gr.</i>	midge	PR	8	8			4	12	27	4	4	8	2	2	6					
Diptera	Chironomidae	<i>Cryptotendipes sp.</i>	midge	GC	6									8								
Diptera	Chironomidae	<i>Dicrotendipes neomodestus</i>	midge	FG	4.5					3	1				10	19	18	16	8	4	4	
Diptera	Chironomidae	<i>Endochironomus nigricans</i>	midge	SH	8											4						
Diptera	Chironomidae	<i>Eukiefferiella sp.</i>	midge	GC	4												6					
Diptera	Chironomidae	<i>Glyptotendipes sp.</i>	midge	FC	10											7						
Diptera	Chironomidae	<i>Microtendipes pedellus gr.</i>	midge	FG	6					1							14					
Diptera	Chironomidae	<i>Nanocladius sp.</i>	midge	GC	3																	
Diptera	Chironomidae	<i>Orthocladius cplx.</i>	midge	GC	6	92	1	6							5	10		160	148		48	
Diptera	Chironomidae	<i>Orthocladius sp.</i>	midge	GC	6		5			3				2	1		8			36		
Diptera	Chironomidae	<i>Paratanytarsus sp.</i>	midge	GC	6																	
Diptera	Chironomidae	<i>Paratendipes basidens</i>	midge	GC	8																	
Diptera	Chironomidae	<i>Pentaneura inconspicua</i>	midge	PR	4.9																	
Diptera	Chironomidae	<i>Polypedilum flavum.</i>	midge	SH	6	4	2	16					24	20		2				4	8	
Diptera	Chironomidae	<i>Polypedilum sp.</i>	midge	SH	6				1			1	48	20			34					
Diptera	Chironomidae	<i>Polypedilum tritum</i>	midge	SH	6															12		
Diptera	Chironomidae	<i>Potthastia longimana</i>	midge	GC	2													4				
Diptera	Chironomidae	<i>Procladius sp.</i>	midge	PR	9											2	12					
Diptera	Chironomidae	<i>Pseudochironomus sp.</i>	midge	GC	5																56	
Diptera	Chironomidae	<i>Rheotanytarsus sp.</i>	midge	FC	6	28	26	52	3	3	3	3	6					32	44	28	4	
Diptera	Chironomidae	<i>Stictochironomus devinctus gr.</i>	midge	OM	5					1	1											
Diptera	Chironomidae	<i>Synorthocladius semivirens</i>	midge	GC	2.5											1			4			
Diptera	Chironomidae	<i>Tanytarsus sp.</i>	midge	FC	6	28		16		2	3		4	4	3	2	28				4	
Diptera	Chironomidae	<i>Thienemanniella xena</i>	midge	GC	3.6	8		4		2					5					4		
Diptera	Chironomidae	<i>Thienemannimyia gr.</i>	midge	PR	6																	
Diptera	Chironomidae	<i>Tribelos jucundum</i>	midge	GC	5.6									30								
Diptera	Chironomidae	<i>Tvetenia vitracies</i>	midge	GC	5	12		6														
Diptera	Chironomidae	<i>Xenochironomus xenolabis</i>	midge	PR	0																	
Diptera	Empididae	<i>Hemerodromia sp.</i>	dance fly	PR	6	1		1												1		
Diptera	Simuliidae	<i>Simulium sp.</i>	black fly	FC	4.8	1	17	18														
Diptera	Tabanidae	<i>Chrysops sp.</i>	deer fly	GC	6								3									
Diptera	Tipulidae	<i>Erioptera</i>	crane fly	GC	7															4		
Metrics:						# Filterers/Collectors	100	64	234	3	10	10	6	18	18	31	51	64	94	89	47	20
						Abundance	358	82	296	84	102	150	84	165	173	165	279	339	353	334	372	190
						Hilsenhoff Sum	1793.9	370.8	1066.2	555.4	642.1	864.9	552.4	1110.4	1051.1	990.9	1603.2	2080	1937.6	1975	2386.2	1167.4
						Mayfly Abundance	99	5	24	19	26	64	19	4	2	25	54	17	49	16	21	2
						Caddisfly Abundance	46	23	149	5	1	4	5	1	0	5	7	10	42	33	8	7
						Isopods, Snails, Leeches Abundance	0	0	0	0	0	1	0	3	6	12	10	4	10	12	4	1
						Surface Dependent Abundance	0	0	0	3	13	14	3	37	13	0	22	0	0	0	0	0
						Taxa Richness	32	16	20	16	18	26	16	20	22	32	44	35	29	25	37	22
						# of Mayfly Taxa	6	2	2	4	6	7	4	3	2	7	8	5	6	4	6	2
						# of Stonefly Taxa	1	0	1	0	0	0	0	0	0	1	1	0	0	1	0	0
						# of Caddisfly Taxa	7	6	6	3	1	2	3	1	0	4	4	5	6	5	6	2
						% Mayfly Comp	27.7	6.1	8.1	22.6	25.5	42.7	22.6	2.4	1.2	15.2	19.4	5.0	13.9	4.8	5.6	1.1
						% Caddisfly Comp	12.8	28.0	50.3	6.0	1.0	2.7	6.0	0.6	0.0	3.0	2.5	2.9	11.9	9.9	2.2	3.7
						% Dominant Taxon	25.7	31.7	33.1	42.9	29.4	21.3	42.9	29.1	17.3	17.6	11.1	21.2	45.3	44.3	26.9	29.5
						% Isopods, Snails, Leeches	0.0	0.0	0.0	0.0	0.0	0.7	0.0	1.8	3.5	7.3	3.6	1.2	2.8	3.6	1.1	0.5
						% Surface Dependent	0.0	0.0	0.0	3.6	12.7	9.3	3.6	22.4	7.5	0.0	7.9	0.0	0.0	0.0	0.0	0.0
						HBI	5.01	4.52	3.60	6.61	6.30	5.77	6.58	6.73	6.08	6.01	5.75	6.14	5.49	5.91	6.41	6.14
						Ratio of Filterers-Collectors/Total	0.28	0.78	0.79	0.04	0.10	0.07	0.07	0.11	0.10	0.19	0.18	0.19	0.27	0.27	0.13	0.11
						EPT Index	14	8	9	7	7	9	7	4	2	12	13	10	12	10	12	4

Appendix C. Benthic Invertebrate Community Data - Grab Samples:
Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	RG-128-50-IC-SBB	RG-128-50-IC-SBC	RH-142-00-IC-SBA	RH-142-00-IC-SBB	RH-142-00-IC-SBC	RH-143-00-IC-SBA	RH-143-00-IC-SBB	RH-143-00-IC-SBC	RI-166-00-SBA	RI-166-00-SBB	RI-166-00-SBC	TR-Ref-01-SBA	TR-Ref-01-SBB	TR-Ref-01-SBC	TR-Ref-02-SBA	TR-Ref-02-SBB	TR-Ref-02-SBC
Nematoda			round worm	PA	9	3	3	7	2	2	4	6	5			1	1	1	3	5	2	6
Tricladida	Planariidae	<i>Dugesia tigrina</i>	flat worm	PR	6									17	3	3	5	1		42	35	8
Hoplonemertea	Tetrastemmatidae	<i>Prostoma graecense</i>	proboscis worm	PR	8	1	1	5			2	9	3	4						1	2	1
Hirudinea	Glossiphoniidae	<i>Helobdella elongata</i>	leech	PR	8													1		1		
Hirudinea	Glossiphoniidae	<i>Helobdella stagnalis</i>	leech	PR	8										7							
Tubificida	Naididae	<i>Dero obtusa</i>	naiaid worm	GC	10																	
Tubificida	Naididae	<i>Nais bretscheri</i>	naiaid worm	GC	6		67				8											
Tubificida	Naididae	<i>Nais sp.</i>	naiaid worm	GC	8	24		2		2	20	29	16	116	116	63					1	
Tubificida	Enchytraeidae		aquatic worm	GC	10																1	
Tubificida	Tubificidae	<i>Branchiura sowerbyi</i>	tube worm	GC	6				2	1	4											
Tubificida	Tubificidae	<i>Limnodrilus hoffmeisteri</i>	tube worm	GC	10																	
Tubificida	Tubificidae	<i>Limnodrilus sp.</i>	tube worm	GC	10			1	1				2	1	16	2	1			1		4
Basommatophora	Ancylidae	<i>Ferrissia rivularis</i>	limpet snail	SC	7		1	16	21	4	3	24	11		2	1		6	7	20	6	7
Basommatophora	Lymnaeidae	<i>Fossaria sp.</i>	pond snail	SC	2.6																	
Basommatophora	Physidae	<i>Physa sp.</i>	pouch snail	SC	9												1			6	7	1
Basommatophora	Planorbidae	<i>Gyraulus parvus</i>	ram's horn snail	SC	5.5																	
Basommatophora	Planorbidae	<i>Helisoma sp.</i>	ram's horn snail	SC	7																	
Basommatophora	Hydrobiidae	<i>Amnicola sp.</i>	dusky snail	SC	4													1				
Mesogastropoda	Pleuroceridae	<i>Goniobasis livescens</i>	horn snail	SC	6			6	1		2	9			1	3	2	2	3	3		1
Mesogastropoda	Pleuroceridae	<i>Leptoxis carinata</i>	horn snail	SC	6			2	2				1						1			
Veneroida	Dreissenidae	<i>Dreissena polymorpha</i>	zebra mussel	FC	8	1	13	26	6		85	2	9				1	5	2	1	3	1
Veneroida	Sphaeriidae	<i>Pisidium sp.</i>	pill clam	FC	4.6						1						2	3		5		1
Hydracarina			water mite	PR	6		1								1					1		
Amphipoda	Gammaridae	<i>Gammarus fasciatus</i>	sideswimmer	GC	3									1					14	5	11	7
Amphipoda	Hyalellidae	<i>Hyalella azteca</i>	sideswimmer	GC	8																	
Decapoda	Cambaridae	<i>Orconectes sp.</i>	crayfish	GC	5																	
Isopoda	Asellidae	<i>Caecidotea sp.</i>	sowbug	GC	6									4		2						
Ephemeroptera	Baetidae	<i>Acerpenna sp.</i>	mayfly	SH	4																1	
Ephemeroptera	Baetidae	<i>Baetis sp.</i>	mayfly	GC	3.1	1							1									
Ephemeroptera	Baetidae	<i>Centroptilum sp.</i>	mayfly	GC	2													2				2
Ephemeroptera	Baetidae	<i>Plauditus sp.</i>	mayfly	GC	4			2	5	3	1	1			1				1			1
Ephemeroptera	Baetiscidae	<i>Baetisca sp.</i>	mayfly	GC	4							2									1	
Ephemeroptera	Caenidae	<i>Caenis sp.</i>	mayfly	GC	7			2			2	4						1		4	7	3
Ephemeroptera	Ephemeridae	<i>Ephemera sp.</i>	mayfly	CG	1						1	1							2			
Ephemeroptera	Ephemeridae	<i>Hexagenia sp.</i>	mayfly	GC	6																	
Ephemeroptera	Heptageniidae	<i>Maccaffertium mediopunctatum</i>	mayfly	SC	3						1									1		
Ephemeroptera	Heptageniidae	<i>Maccaffertium sp.</i>	mayfly	SC	4		4	1	1	2	18	9	3			1	7	30	44	49	35	34
Ephemeroptera	Heptageniidae	<i>Stenacron interpunctatum</i>	mayfly	OM	7		1				3			1			6	9	11	20	11	7
Ephemeroptera	Heptageniidae	<i>Stenonema femoratum</i>	mayfly	OM	5																	
Ephemeroptera	Isonychiidae	<i>Isonychia sp.</i>	mayfly	FC	2																	
Ephemeroptera	Leptophlebiidae	<i>Paraleptophlebia sp.</i>	mayfly	GC	1												5	10		6	2	4
Ephemeroptera	Potamanthidae	<i>Anthopotamus verticis gr.</i>	mayfly	GC	3.2	2						6	1				4			1	1	1
Ephemeroptera	Tricorythidae	<i>Tricorythodes sp.</i>	mayfly	GC	4	11	16	6	5		33	21	24	4		2		2		3	2	8
Odonata	Calopterygidae	<i>Haeterina sp.</i>	damselfly	PR	6																	
Odonata	Coenagrionidae	<i>Argia sp.</i>	damselfly	PR	5.1		2	1		1	4			3					2		3	1
Odonata	Coenagrionidae	<i>Enallagma sp.</i>	damselfly	PR	9		1					3	4	8	12	2						
Odonata	Corduliidae	<i>Neurocordulia sp.</i>	dragonfly	PR	3			1														
Odonata	Gomphidae		dragonfly	PR	4																	
Odonata	Gomphidae	<i>Gomphus sp.</i>	dragonfly	PR	5																	
Plecoptera	Taeniopterygidae	<i>Taeniopteryx sp.</i>	stonefly	SH	2	4										1	1	7	18	1	1	4
Megaloptera	Sialidae	<i>Sialis sp.</i>	alderfly	PR	4																	
Hemiptera	Corixidae	<i>Sigara lineata</i>	water boatmen	GC	8	1																
Trichoptera	Brachycentridae	<i>Brachycentrus sp.</i>	caddisfly	FC	1				1			1	1			2						
Trichoptera	Glossosomatidae	<i>Protoptila sp.</i>	caddisfly	SC	1													6	13	2		4
Trichoptera	Helicopsychidae	<i>Helicopsyche borealis</i>	caddisfly	SC	3														1			
Trichoptera	Hydropsychidae	<i>Cheumatopsyche sp.</i>	caddisfly	FC	5	3	17	9	5	3	19	2	1	48	2	2			4	60	2	3
Trichoptera	Hydropsychidae	<i>Hydropsyche aerata</i>	caddisfly	FC	2.6	1	3	2	1			1							13	16	4	6
Trichoptera	Hydropsychidae	<i>Hydropsyche morosa</i>	caddisfly	FC	2														1			
Trichoptera	Hydropsychidae	<i>Hydropsyche phalerata</i>	caddisfly	FC	1		3	12	4		5		1	2		6			5	137	3	6
Trichoptera	Hydropsychidae	<i>Hydropsyche sparna</i>	caddisfly	FC	1														4			
Trichoptera	Hydropsychidae	<i>Hydropsydrops</i>																				

Appendix C. Benthic Invertebrate Community Data - Grab Samples:
Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	RG-128-50-IC-SBB	RG-128-50-IC-SBC	RH-142-00-IC-SBA	RH-142-00-IC-SBB	RH-142-00-IC-SBC	RH-143-00-IC-SBA	RH-143-00-IC-SBB	RH-143-00-IC-SBC	RI-166-00-SBA	RI-166-00-SBB	RI-166-00-SBC	TR-Ref-01-SBA	TR-Ref-01-SBB	TR-Ref-01-SBC	TR-Ref-02-SBA	TR-Ref-02-SBB	TR-Ref-02-SBC	
Diptera	Chironomidae	<i>Ablabesmyia janta</i>	midge	OM	4.9																		
Diptera	Chironomidae	<i>Ablabesmyia mallochi</i>	midge	OM	8						4							1		1			
Diptera	Chironomidae	<i>Chironomini</i>	midge	GC	6										4								
Diptera	Chironomidae	<i>Chironomus sp.</i>	midge	GC	10		4					16	32	4		4							
Diptera	Chironomidae	<i>Cladotanytarsus sp.</i>	midge	GC	7	12																	
Diptera	Chironomidae	<i>Corynoneura sp.</i>	midge	GC	7																		
Diptera	Chironomidae	<i>Cricotopus bicintus</i>	midge	OM	6.7																		
Diptera	Chironomidae	<i>Cricotopus sp.</i>	midge	SH	7					8		24											
Diptera	Chironomidae	<i>Cricotopus trifasciata</i>	midge	OM	7																		
Diptera	Chironomidae	<i>Cryptochironomus fulvus gr.</i>	midge	PR	8												1	2		2			
Diptera	Chironomidae	<i>Cryptotendipes sp.</i>	midge	GC	6																		
Diptera	Chironomidae	<i>Dicrotendipes neomodestus</i>	midge	FG	4.5		72	8		2	20		4	4			1	8	2	2		3	
Diptera	Chironomidae	<i>Endochironomus nigricans</i>	midge	SH	8																		
Diptera	Chironomidae	<i>Eukiefferiella sp.</i>	midge	GC	4																		
Diptera	Chironomidae	<i>Glyptotendipes sp.</i>	midge	FC	10																		
Diptera	Chironomidae	<i>Microtendipes pedellus gr.</i>	midge	FG	6											4	3	4					
Diptera	Chironomidae	<i>Nanocladius sp.</i>	midge	GC	3															1			
Diptera	Chironomidae	<i>Orthocladius cplx.</i>	midge	GC	6		120			24	76	32	36	16	424	68			4				
Diptera	Chironomidae	<i>Orthocladius sp.</i>	midge	GC	6	80		84	136			24	64										
Diptera	Chironomidae	<i>Paratanytarsus sp.</i>	midge	GC	6																		
Diptera	Chironomidae	<i>Paratendipes basidens</i>	midge	GC	8	4																	
Diptera	Chironomidae	<i>Pentaneura inconspicua</i>	midge	PR	4.9						4												
Diptera	Chironomidae	<i>Polypedilum flavum.</i>	midge	SH	6	4	8	4				12		28				10	58	4	4	8	
Diptera	Chironomidae	<i>Polypedilum sp.</i>	midge	SH	6						4						1						
Diptera	Chironomidae	<i>Polypedilum tritum</i>	midge	SH	6																		
Diptera	Chironomidae	<i>Potthastia longimanna</i>	midge	GC	2															1			
Diptera	Chironomidae	<i>Procladius sp.</i>	midge	PR	9															1			
Diptera	Chironomidae	<i>Pseudochironomus sp.</i>	midge	GC	5	64	76	8			32	12	4	4									
Diptera	Chironomidae	<i>Rheotanytarsus sp.</i>	midge	FC	6	32	28	64	120	6	24	36	56	20	28	44	1	17	18	3	5		
Diptera	Chironomidae	<i>Stictochironomus devinctus gr.</i>	midge	OM	5																		
Diptera	Chironomidae	<i>Synorthocladius semivirens</i>	midge	GC	2.5																		
Diptera	Chironomidae	<i>Tanytarsus sp.</i>	midge	FC	6					3			20		12					1	4	5	
Diptera	Chironomidae	<i>Thienemanniella xena</i>	midge	GC	3.6		4		8	2							1		1	3			
Diptera	Chironomidae	<i>Thienemannimyia gr.</i>	midge	PR	6														1		2		
Diptera	Chironomidae	<i>Tribelos jucundum</i>	midge	GC	5.6																		
Diptera	Chironomidae	<i>Tvetenia vitracies</i>	midge	GC	5																		
Diptera	Chironomidae	<i>Xenochironomus xenolabis</i>	midge	PR	0	4																	
Diptera	Empididae	<i>Hemerodromia sp.</i>	dance fly	PR	6																		
Diptera	Simuliidae	<i>Simulium sp.</i>	black fly	FC	4.8		2	1	4	2				1	5	7	18			1		1	
Diptera	Tabanidae	<i>Chrysops sp.</i>	deer fly	GC	6																		
Diptera	Tipulidae	<i>Erioptera</i>	crane fly	GC	7																		
Metrics:						# Filterers/Collectors	47	156	137	154	17	166	51	103	79	50	81	10	82	409	25	10	38
						Abundance	268	495	307	364	66	415	319	324	338	629	241	96	251	629	255	174	183
						Hilsenhoff Sum	1537.1	2699.5	1810.1	2144	392.9	2504.3	2031.8	2100.1	2236.3	4043.2	1524.4	465.3	1195.7	2521	1347.9	917.1	881.5
						Mayfly Abundance	14	21	11	11	5	59	44	29	5	1	3	26	54	62	89	57	60
						Caddisfly Abundance	16	45	40	26	4	37	16	13	50	3	15	15	72	411	20	19	44
						Isopods, Snails, Leeches Abundance	0	1	24	24	4	5	33	12	4	10	6	3	10	11	30	13	9
						Surface Dependent Abundance	1	0	0	1	0	0	1	0	0	0	0	3	2	0	0	0	0
						Taxa Richness	23	29	30	24	16	33	33	28	21	18	23	32	39	36	43	32	34
						# of Mayfly Taxa	3	3	4	3	2	7	7	4	2	1	2	6	6	5	8	8	8
						# of Stonefly Taxa	1	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
						# of Caddisfly Taxa	5	7	7	7	2	5	8	5	2	2	4	5	10	11	6	5	8
						% Mayfly Comp	5.2	4.2	3.6	3.0	7.6	14.2	13.8	9.0	1.5	0.2	1.2	27.1	21.5	9.9	34.9	32.8	32.8
						% Caddisfly Comp	6.0	9.1	13.0	7.1	6.1	8.9	5.0	4.0	14.8	0.5	6.2	15.6	28.7	65.3	7.8	10.9	24.0
						% Dominant Taxon	29.9	24.2	27.4	37.4	36.4	20.5	11.3	19.8	34.3	67.4	28.2	14.6	12.0	26.9	19.2	20.1	18.6
						% Isopods, Snails, Leeches	0.0	0.2	7.8	6.6	6.1	1.2	10.3	3.7	1.2	1.6	2.5	3.1	4.0	1.7	11.8	7.5	4.9
						% Surface Dependent	0.4	0.0	0.0	0.3	0.0	0.0	0.3	0.0	0.0	0.0	0.0	3.1	0.8	0.0	0.0	0.0	0.0
						HBI	5.74	5.45	5.90	5.89	5.95	6.03	6.37	6.48	6.62	6.43	6.33	4.85	4.76	4.01	5.29	5.27	4.82
						Ratio of Filterers-Collectors/Total	0.18	0.32	0.45	0.42	0.26	0.40	0.16	0.32	0.23	0.08	0.34	0.10	0.33	0.65	0.10	0.06	0.21
						EPT Index	9	10	11	10	4	12	15	9	4	3	7	12	17	17	15	14	17

Appendix C. Benthic Invertebrate Community Data - Grab Samples:
Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	RE-062-00-IC-SBA	RE-062-00-IC-SBB	RE-062-00-IC-SBC	RF-085-00-IC-SBA	RF-085-00-IC-SBB	RF-085-00-IC-SBC	RF-090-00-IC-SBA	RF-090-00-IC-SBB	RF-090-00-IC-SBC	RG-140-00-IC-SBA	RG-140-00-IC-SBB	RG-140-00-IC-SBC	RH-151-50-IC-SBA	RH-151-50-IC-SBB	RH-151-50-IC-SBC	RI-169-50-IC-SBA
Nematoda			round worm	PA	9	1			1			1		4	1	2	4	8	1	16	1
Tricladida	Planariidae	<i>Dugesia tigrina</i>	flat worm	PR	6								3							1	
Hoplonemertea	Tetrahastemmatidae	<i>Prostoma graecense</i>	proboscis worm	PR	8	1			1		3	1			3	2		4	13	9	1
Hirudinea	Glossiphoniidae	<i>Helobdella elongata</i>	leech	PR	8																
Hirudinea	Glossiphoniidae	<i>Helobdella stagnalis</i>	leech	PR	8																
Tubificida	Naididae	<i>Dero obtusa</i>	naiad worm	GC	10																
Tubificida	Naididae	<i>Nais bretscheri</i>	naiad worm	GC	6	1						8								8	6
Tubificida	Naididae	<i>Nais</i> sp.	naiad worm	GC	8							1		11	1		160	22	12	8	
Tubificida	Enchytraeidae		aquatic worm	GC	10																
Tubificida	Tubificidae	<i>Branchiura sowerbyi</i>	tube worm	GC	6			1													
Tubificida	Tubificidae	<i>Limnodrilus hoffmeisteri</i>	tube worm	GC	10																
Tubificida	Tubificidae	<i>Limnodrilus</i> sp.	tube worm	GC	10	2						1						1		18	1
Basommatophora	Ancylidae	<i>Ferrissia rivularis</i>	limpet snail	SC	7	13	43	23	18	9	9	3	1		17	56	16	3	16	84	6
Basommatophora	Lymnaeidae	<i>Fossaria</i> sp.	pond snail	SC	2.6																
Basommatophora	Physidae	<i>Physa</i> sp.	pouch snail	SC	9											1					
Basommatophora	Planorbidae	<i>Gyraulus parvus</i>	ram's horn snail	SC	5.5																
Basommatophora	Planorbidae	<i>Helisoma</i> sp.	ram's horn snail	SC	7																
Basommatophora	Hydrobiidae	<i>Amnicola</i> sp.	dusky snail	SC	4																
Mesogastropoda	Pleuroceridae	<i>Goniobasis livescens</i>	horn snail	SC	6			2									1		3	5	4
Mesogastropoda	Pleuroceridae	<i>Leptoxis carinata</i>	horn snail	SC	6	1	1	2										1			
Veneroida	Dreissenidae	<i>Dreissena polymorpha</i>	zebra mussel	FC	8	55	13	13	24	10	4					1		1		6	
Veneroida	Sphaeriidae	<i>Pisidium</i> sp.	pill clam	FC	4.6			1											1		1
Hydracarina			water mite	PR	6	6	7	3	1				2	2				1	2		
Amphipoda	Gammaridae	<i>Gammarus fasciatus</i>	sideswimmer	GC	3	1	1	2							1	2	1			7	
Amphipoda	Hyalellidae	<i>Hyalella azteca</i>	sideswimmer	GC	8																
Decapoda	Cambaridae	<i>Orconectes</i> sp.	crayfish	GC	5																
Isopoda	Asellidae	<i>Caecidotea</i> sp.	sowbug	GC	6												1				
Ephemeroptera	Baetidae	<i>Acerpenna</i> sp.	mayfly	SH	4																
Ephemeroptera	Baetidae	<i>Baetis</i> sp.	mayfly	GC	3.1																
Ephemeroptera	Baetidae	<i>Centroptilum</i> sp.	mayfly	GC	2																
Ephemeroptera	Baetidae	<i>Plautidius</i> sp.	mayfly	GC	4	26	5	18	4	3	3	16	5	2	1	21	3	1	2		4
Ephemeroptera	Baetiscidae	<i>Baetisca</i> sp.	mayfly	GC	4	4	16	12	2			2				1		1	2	1	1
Ephemeroptera	Caenidae	<i>Caenis</i> sp.	mayfly	GC	7	3			1												
Ephemeroptera	Ephemeridae	<i>Ephemera</i> sp.	mayfly	CG	1									1	3	7	3	1	2	6	
Ephemeroptera	Hexageniidae	<i>Hexagenia</i> sp.	mayfly	GC	6															5	
Ephemeroptera	Heptageniidae	<i>Maccaffertium mediopunctatum</i>	mayfly	SC	3																
Ephemeroptera	Heptageniidae	<i>Maccaffertium</i> sp.	mayfly	SC	4	7	16	8	1	14					7	4	8		1		1
Ephemeroptera	Heptageniidae	<i>Stenacron interpunctatum</i>	mayfly	OM	7	1				3		1			1	2				1	
Ephemeroptera	Heptageniidae	<i>Stenonema femoratum</i>	mayfly	OM	5						1										
Ephemeroptera	Isonychiidae	<i>Isonychia</i> sp.	mayfly	FC	2	3		13		1						2					
Ephemeroptera	Leptophlebiidae	<i>Paraleptophlebia</i> sp.	mayfly	GC	1															1	
Ephemeroptera	Potamanthidae	<i>Anthopotamus verticis</i> gr.	mayfly	GC	3.2								3			1		11	1	2	
Ephemeroptera	Tricorythidae	<i>Tricorythodes</i> sp.	mayfly	GC	4	57	200	176	24	53	11	5			23	51	20	1	4	41	7
Odonata	Calopterygidae	<i>Haeterina</i> sp.	damselfly	PR	6																
Odonata	Coenagrionidae	<i>Argia</i> sp.	damselfly	PR	5.1	3		1		4								2			
Odonata	Coenagrionidae	<i>Enallagma</i> sp.	damselfly	PR	9	1									1					8	12
Odonata	Corduliidae	<i>Neurocordulia</i> sp.	dragonfly	PR	3																
Odonata	Gomphidae		dragonfly	PR	4													1			
Odonata	Gomphidae	<i>Gomphus</i> sp.	dragonfly	PR	5																1
Plecoptera	Taeniopterygidae	<i>Taeniopteryx</i> sp.	stonefly	SH	2	2		1	2			5		2	3	14	14	1	1	6	7
Megaloptera	Sialidae	<i>Sialis</i> sp.	alderfly	PR	4	2															
Hemiptera	Corixidae	<i>Sigara lineata</i>	water boatmen	GC	8																
Trichoptera	Brachycentridae	<i>Brachycentrus</i> sp.	caddisfly	FC	1	2	3	2	4	2	3		1		4	2	2		1	1	
Trichoptera	Glossosomatidae	<i>Protoptila</i> sp.	caddisfly	SC	1	1	5	5					1								
Trichoptera	Helicopsychidae	<i>Helicopsyche borealis</i>	caddisfly	SC	3		2	2													
Trichoptera	Hydropsychidae	<i>Cheumatopsyche</i> sp.	caddisfly	FC	5	88	274	108	57	213	36	16	8	7	68	129	68	1	2	6	6
Trichoptera	Hydropsychidae	<i>Hydropsyche aerata</i>	caddisfly	FC	2.6	4	52	44	12	16	12		1			8	12	1			1
Trichoptera	Hydropsychidae	<i>Hydropsyche morosa</i>	caddisfly	FC	2								1		4						
Trichoptera	Hydropsychidae	<i>Hydropsyche phalerata</i>	caddisfly	FC	1	84	76	232	60	68	84	31	8	36	40	24	40	1	6	4	3
Trichoptera	Hydropsychidae	<i>Hydropsyche sparna</i>	caddisfly	FC	1																
Trichoptera	Hydropsychidae	<i>Hydropsyche</i> sp.	caddisfly	FC	5	40	24	100	28	8	40	3	13	14	44	25	36	3	4	17	17
Trichoptera	Hydroptilidae	<i>Hydroptilia</i> sp.	caddisfly	PR	6	2	6	1	2	1		2	2			1				1	
Trichoptera	Lepidostomatidae	<i>Lepidostoma</i> sp.	caddisfly	SH	1																
Trichoptera	Leptoceridae	<i>Nectopsyche</i> sp.	caddisfly	SH	2.4	9		4	1					1	1	2	2	1			1
Trichoptera	Leptoceridae	<i>Oecetis</i> sp.	caddisfly	PR	8	1															
Trichoptera	Leptoceridae	<i>Triaenodes</i> sp.	caddisfly	SH	3													1		3	
Trichoptera	Polycentropodidae	<i>Cymellus fraternus</i>	caddisfly	FC	8																
Trichoptera	Polycentropodidae	<i>Neureclipsis</i> sp.	caddisfly	FC	7																
Trichoptera	Polycentropodidae	<i>Polycentropus</i> sp.	caddisfly	PR	6	4															
Trichoptera	Uenoidae	<i>Neophylax</i> sp.	caddisfly	SC	3																
Lepidoptera	Pyrallidae	<i>Parapoynx</i> sp.	moth	SH	5	3	1		2				1		1	2				1	3
Lepidoptera	Pyrallidae	<i>Petrophila</i> sp.	moth	SC	2.7	2	3	6	2	6	7		1							1	
Coleoptera	Elmidae	<i>Dubiraphia vittata</i>	riffle beetle	OM	7	17	4	14	2				1			9		41	35	123	43
Coleoptera	Elmidae	<i>Macronychus glabratus</i>	riffle beetle	OM	4	1				1							2			1	
Coleoptera	Elmidae	<i>Optioservus</i> sp.	riffle beetle	SC	4	19	20	5	3	2	2						1			1	
Coleoptera	Elmidae	<i>Stenelmis crenata</i> gr.	riffle beetle	SC	5	18	12	13	13	14	2	1	1			1		2	2	4	
Coleoptera	Gyrinidae	<i>Dineutus</i> sp.	whirligig beetle	PR	3.7											3					
Coleoptera	Hydrophilidae	<i>Berosus</i> sp.	scavenger beetle	PR	6.7	1															
Coleoptera	Psephenidae	<i>Ectopria nervosus</i>	false water penny	SC	5	1	1														
Coleoptera	Psephenidae	<i>Psephenus herricki</i>	water penny	SC	4																
Diptera	Athericidae	<i>Atherix</i> sp.	watersnipe fly	PR	4	1	1														
Diptera	Ceratopogonidae	<i>Palpomyia</i> gr.	biting midge	PR	6																
Diptera	Ceratopogonidae	<i>Probezzia</i> sp.	biting midge	PR	6													1			

Appendix C. Benthic Invertebrate Community Data - Grab Samples:
Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	RE-062-00-IC-SBA	RE-062-00-IC-SBB	RE-062-00-IC-SBC	RF-085-00-IC-SBA	RF-085-00-IC-SBB	RF-085-00-IC-SBC	RF-090-00-IC-SBA	RF-090-00-IC-SBB	RF-090-00-IC-SBC	RG-140-00-IC-SBA	RG-140-00-IC-SBB	RG-140-00-IC-SBC	RH-151-50-IC-SBA	RH-151-50-IC-SBB	RH-151-50-IC-SBC	RI-169-50-IC-SBA
Diptera	Chironomidae	<i>Ablabesmyia janta</i>	midge	OM	4.9																
Diptera	Chironomidae	<i>Ablabesmyia mallochii</i>	midge	OM	8																
Diptera	Chironomidae	Chironomini	midge	GC	6																
Diptera	Chironomidae	<i>Chironomus sp.</i>	midge	GC	10										8			8		8	
Diptera	Chironomidae	<i>Cladotanytarsus sp.</i>	midge	GC	7							8									
Diptera	Chironomidae	<i>Corynoneura sp.</i>	midge	GC	7																
Diptera	Chironomidae	<i>Cricotopus bicintus</i>	midge	OM	6.7			24		32	48				88	80		36	124	148	80
Diptera	Chironomidae	<i>Cricotopus sp.</i>	midge	SH	7																
Diptera	Chironomidae	<i>Cricotopus trifasciata</i>	midge	OM	7	36	4					36		11							32
Diptera	Chironomidae	<i>Cryptochironomus fulvus gr.</i>	midge	PR	8															4	
Diptera	Chironomidae	<i>Cryptotendipes sp.</i>	midge	GC	6																
Diptera	Chironomidae	<i>Dicrotendipes neomodestus</i>	midge	FG	4.5	8	4	4	4	4	4				4	12	4			12	
Diptera	Chironomidae	<i>Endochironomus nigricans</i>	midge	SH	8																
Diptera	Chironomidae	<i>Eukiefferiella sp.</i>	midge	GC	4																
Diptera	Chironomidae	<i>Glyptotendipes sp.</i>	midge	FC	10										4						
Diptera	Chironomidae	<i>Microtendipes pedellus gr.</i>	midge	FG	6																
Diptera	Chironomidae	<i>Nanocladius sp.</i>	midge	GC	3																
Diptera	Chironomidae	<i>Orthocladius cplx.</i>	midge	GC	6	68	88	76	116	120	96	72	92	48	88	188	144	76	80	96	80
Diptera	Chironomidae	<i>Orthocladius sp.</i>	midge	GC	6	36									44	80	144				
Diptera	Chironomidae	<i>Paratanytarsus sp.</i>	midge	GC	6																
Diptera	Chironomidae	<i>Paratendipes basidens</i>	midge	GC	8		20														
Diptera	Chironomidae	<i>Pentaneura inconspicua</i>	midge	PR	4.9																
Diptera	Chironomidae	<i>Polypedilum flavum</i>	midge	SH	6	16	40	24	4	8		8	36	4	8	20	4		8	4	8
Diptera	Chironomidae	<i>Polypedilum sp.</i>	midge	SH	6								20					4			
Diptera	Chironomidae	<i>Polypedilum tritum</i>	midge	SH	6																
Diptera	Chironomidae	<i>Potthastia longimana</i>	midge	GC	2																
Diptera	Chironomidae	<i>Procladius sp.</i>	midge	PR	9																
Diptera	Chironomidae	<i>Pseudochironomus sp.</i>	midge	GC	5													4			
Diptera	Chironomidae	<i>Rheotanytarsus sp.</i>	midge	FC	6	28	20	72	40	40	28	24	60	33	24	48	68	32	36	56	56
Diptera	Chironomidae	<i>Stictochironomus devinctus gr.</i>	midge	OM	5																
Diptera	Chironomidae	<i>Synorthocladius semivirens</i>	midge	GC	2.5																
Diptera	Chironomidae	<i>Tanytarsus sp.</i>	midge	FC	6																
Diptera	Chironomidae	<i>Thienemanniella xena</i>	midge	GC	3.6			12	12	16		4		3	12	28	20			8	12
Diptera	Chironomidae	<i>Thienemannimyia gr.</i>	midge	PR	6																
Diptera	Chironomidae	<i>Tribelos jucundum</i>	midge	GC	5.6																
Diptera	Chironomidae	<i>Tvetenia vitracies</i>	midge	GC	5		4			4		36									
Diptera	Chironomidae	<i>Xenochironomus xenolabis</i>	midge	PR	0																
Diptera	Empididae	<i>Hemerodromia sp.</i>	dance fly	PR	6		1									1					1
Diptera	Simuliidae	<i>Simulium sp.</i>	black fly	FC	4.8	76	69	380	10	32	37	88	52	32	4	7	17		1		14
Diptera	Tabanidae	<i>Chrysops sp.</i>	deer fly	GC	6																
Diptera	Tipulidae	<i>Erioptera</i>	crane fly	GC	7																
<i>Metrics:</i>																					
				# Filterers/Collectors		388	535	969	239	394	248	162	144	122	192	262	247	39	51	102	98
				Abundance		756	1036	1405	451	684	430	375	313	209	504	842	795	272	358	732	410
				Hilsenhoff Sum		3734.2	4796.5	5909.9	2186.2	3258.8	1976.3	1916.8	1715.5	1037.8	2683.4	4564.3	4557.6	1746.6	2274.4	4668.5	2492
				Mayfly Abundance		101	237	227	32	74	15	24	8	3	35	89	34	15	10	57	13
				Caddisfly Abundance		235	442	498	164	308	175	52	35	58	161	191	160	8	13	32	28
				Isopods, Snails, Leeches Abundance		14	44	27	18	9	9	3	1	0	17	57	18	4	19	89	10
				Surface Dependent Abundance		2	1	0	0	0	0	0	0	0	0	3	0	0	0	0	0
				Taxa Richness		46	33	36	29	26	19	25	22	15	28	37	26	31	24	39	29
				# of Mayfly Taxa		7	4	5	5	5	3	4	2	2	5	8	4	5	5	7	4
				# of Stonefly Taxa		1	0	1	1	0	0	1	0	1	1	1	1	1	1	1	1
				# of Caddisfly Taxa		10	8	9	7	6	5	4	8	4	6	7	6	6	4	6	5
				% Mayfly Comp		13.4	22.9	16.2	7.1	10.8	3.5	6.4	2.6	1.4	6.9	10.6	4.3	5.5	2.8	7.8	3.2
				% Caddisfly Comp		31.1	42.7	35.4	36.4	45.0	40.7	13.9	11.2	27.8	31.9	22.7	20.1	2.9	3.6	4.4	6.8
				% Dominant Taxon		11.6	26.4	27.0	25.7	31.1	22.3	23.5	29.4	23.0	17.5	22.3	20.1	27.9	34.6	20.2	19.5
				% Isopods, Snails, Leeches		1.9	4.2	1.9	4.0	1.3	2.1	0.8	0.3	0.0	3.4	6.8	2.3	1.5	5.3	12.2	2.4
				% Surface Dependent		0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
				HBI		4.94	4.63	4.21	4.85	4.76	4.60	5.11	5.48	4.97	5.32	5.42	5.73	6.42	6.35	6.38	6.08
				Ratio of Filterers-Collectors/Total		0.51	0.52	0.69	0.53	0.58	0.58	0.43	0.46	0.58	0.38	0.31	0.31	0.14	0.14	0.14	0.24
				EPT Index		18	12	15	13	11	8	9	10	7	12	16	11	12	10	14	10

Appendix C. Benthic Invertebrate Community Data - Grab Samples:
Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	RI-169-50-IC-SBB	RI-169-50-IC-SBC	RK-201-00-IC-SBA	RK-201-00-IC-SBB	RK-201-00-IC-SBC	RM-285-00-IC-SBA	RM-285-00-IC-SBB	RM-285-00-IC-SBC
Nematoda			round worm	PA	9	8		3					1
Tricladida	Planariidae	<i>Dugesia tigrina</i>	flat worm	PR	6	24	5						
Hoplonemertea	Tetrahastemmatidae	<i>Prostoma graecense</i>	proboscis worm	PR	8	1	1	1	1	1		1	
Hirudinea	Glossiphoniidae	<i>Helobdella elongata</i>	leech	PR	8								
Hirudinea	Glossiphoniidae	<i>Helobdella stagnalis</i>	leech	PR	8								
Tubificida	Naididae	<i>Dero obtusa</i>	naiaid worm	GC	10		7						
Tubificida	Naididae	<i>Nais bretscheri</i>	naiaid worm	GC	6			3	4	18	3	8	7
Tubificida	Naididae	<i>Nais</i> sp.	naiaid worm	GC	8	9	15	7	13		5	11	
Tubificida	Enchytraeidae		aquatic worm	GC	10								
Tubificida	Tubificidae	<i>Branchiura sowerbyi</i>	tube worm	GC	6				3	3		1	1
Tubificida	Tubificidae	<i>Limnodrilus hoffmeisteri</i>	tube worm	GC	10	2							
Tubificida	Tubificidae	<i>Limnodrilus</i> sp.	tube worm	GC	10		12						
Basommatophora	Ancylidae	<i>Ferrissia rivularis</i>	limpet snail	SC	7	11	6	3	1	1	12	5	1
Basommatophora	Lymnaeidae	<i>Fossaria</i> sp.	pond snail	SC	2.6								
Basommatophora	Physidae	<i>Physa</i> sp.	pouch snail	SC	9								
Basommatophora	Planorbidae	<i>Gyraulus parvus</i>	ram's horn snail	SC	5.5		1						
Basommatophora	Planorbidae	<i>Helisoma</i> sp.	ram's horn snail	SC	7								
Basommatophora	Hydrobiidae	<i>Amnicola</i> sp.	dusky snail	SC	4								
Mesogastropoda	Pleuroceridae	<i>Goniobasis livescens</i>	horn snail	SC	6		3					12	1
Mesogastropoda	Pleuroceridae	<i>Leptoxis carinata</i>	horn snail	SC	6								
Veneroida	Dreissenidae	<i>Dreissena polymorpha</i>	zebra mussel	FC	8		1	13	14	1	4	6	2
Veneroida	Sphaeriidae	<i>Pisidium</i> sp.	pill clam	FC	4.6		1					1	
Hydracarina			water mite	PR	6			1			1		
Amphipoda	Gammaridae	<i>Gammarus fasciatus</i>	sideswimmer	GC	3			1	1				1
Amphipoda	Hyalellidae	<i>Hyalella azteca</i>	sideswimmer	GC	8								
Decapoda	Cambaridae	<i>Orconectes</i> sp.	crayfish	GC	5								
Isopoda	Asellidae	<i>Caecidotea</i> sp.	sowbug	GC	6	1	1						
Ephemeroptera	Baetidae	<i>Acerpenna</i> sp.	mayfly	SH	4								
Ephemeroptera	Baetidae	<i>Baetis</i> sp.	mayfly	GC	3.1								
Ephemeroptera	Baetidae	<i>Centroptilum</i> sp.	mayfly	GC	2								
Ephemeroptera	Baetidae	<i>Plautidius</i> sp.	mayfly	GC	4		1				10		2
Ephemeroptera	Baetiscidae	<i>Baetisca</i> sp.	mayfly	GC	4	2		1				1	
Ephemeroptera	Caenidae	<i>Caenis</i> sp.	mayfly	GC	7			12	8	7	9	4	4
Ephemeroptera	Ephemeridae	<i>Ephemera</i> sp.	mayfly	CG	1	1							
Ephemeroptera	Ephemeridae	<i>Hexagenia</i> sp.	mayfly	GC	6								
Ephemeroptera	Heptageniidae	<i>Maccaffertium mediopunctatum</i>	mayfly	SC	3			2				1	
Ephemeroptera	Heptageniidae	<i>Maccaffertium</i> sp.	mayfly	SC	4			4	3		4	2	2
Ephemeroptera	Heptageniidae	<i>Stenacron interpunctatum</i>	mayfly	OM	7			7		1	3	1	
Ephemeroptera	Heptageniidae	<i>Stenonema femoratum</i>	mayfly	OM	5			1		2			
Ephemeroptera	Isonychiidae	<i>Isonychia</i> sp.	mayfly	FC	2			1			1		
Ephemeroptera	Paraleptophlebiidae	<i>Paraleptophlebia</i> sp.	mayfly	GC	1			5	3		2	8	1
Ephemeroptera	Potamanthidae	<i>Anthopotamus verticis</i> gr.	mayfly	GC	3.2			2	1	1			
Ephemeroptera	Tricorythidae	<i>Tricorythodes</i> sp.	mayfly	GC	4	1		16	8	15	20	29	9
Odonata	Calopterygidae	<i>Haeterina</i> sp.	damselfly	PR	6								
Odonata	Coenagrionidae	<i>Argia</i> sp.	damselfly	PR	5.1	4		1			1	2	
Odonata	Coenagrionidae	<i>Enallagma</i> sp.	damselfly	PR	9						3	5	1
Odonata	Corduliidae	<i>Neurocordulia</i> sp.	dragonfly	PR	3								
Odonata	Gomphidae		dragonfly	PR	4								
Odonata	Gomphidae	<i>Gomphus</i> sp.	dragonfly	PR	5							1	
Plecoptera	Taeniopterygidae	<i>Taeniopteryx</i> sp.	stonefly	SH	2		2	4		2	10	1	10
Megaloptera	Sialidae	<i>Sialis</i> sp.	alderfly	PR	4								
Hemiptera	Corixidae	<i>Sigara lineata</i>	water boatmen	GC	8								
Trichoptera	Brachycentridae	<i>Brachycentrus</i> sp.	caddisfly	FC	1	1	1	1				2	10
Trichoptera	Glossosomatidae	<i>Protophila</i> sp.	caddisfly	SC	1								
Trichoptera	Helicopsychidae	<i>Helicopsyche borealis</i>	caddisfly	SC	3								
Trichoptera	Hydropsychidae	<i>Cheumatopsyche</i> sp.	caddisfly	FC	5	5	4	11	9	9	28	9	14
Trichoptera	Hydropsychidae	<i>Hydropsyche aerata</i>	caddisfly	FC	2.6								
Trichoptera	Hydropsychidae	<i>Hydropsyche morosa</i>	caddisfly	FC	2								
Trichoptera	Hydropsychidae	<i>Hydropsyche phalerata</i>	caddisfly	FC	1	3	3	1	1		15	4	8
Trichoptera	Hydropsychidae	<i>Hydropsyche spuma</i>	caddisfly	FC	1								
Trichoptera	Hydropsychidae	<i>Hydropsyche</i> sp.	caddisfly	FC	5	1	15	3		3	48	17	34
Trichoptera	Hydroptilidae	<i>Hydroptilia</i> sp.	caddisfly	PR	6				1		1		
Trichoptera	Lepidostomatidae	<i>Lepidostoma</i> sp.	caddisfly	SH	1								
Trichoptera	Leptoceridae	<i>Nectopsyche</i> sp.	caddisfly	SH	2.4	1				2		1	2
Trichoptera	Leptoceridae	<i>Oecetis</i> sp.	caddisfly	PR	8								
Trichoptera	Leptoceridae	<i>Triaenodes</i> sp.	caddisfly	SH	3								
Trichoptera	Polycentropodidae	<i>Cymellus fraternus</i>	caddisfly	FC	8			7	2	2			
Trichoptera	Polycentropodidae	<i>Neureclipsis</i> sp.	caddisfly	FC	7								
Trichoptera	Polycentropodidae	<i>Polycentropus</i> sp.	caddisfly	PR	6			1					
Trichoptera	Uenoidae	<i>Neophylax</i> sp.	caddisfly	SC	3								
Lepidoptera	Pyrilidae	<i>Parapoynx</i> sp.	moth	SH	5	4	1						3
Lepidoptera	Pyrilidae	<i>Petrophila</i> sp.	moth	SC	2.7						1		
Coleoptera	Elmidae	<i>Dubiraphia vittata</i>	riffle beetle	OM	7	6	17		7	1		5	2
Coleoptera	Elmidae	<i>Macronychus glabratus</i>	riffle beetle	OM	4								
Coleoptera	Elmidae	<i>Optioservus</i> sp.	riffle beetle	SC	4								
Coleoptera	Elmidae	<i>Stenelmis crenata</i> gr.	riffle beetle	SC	5	1				1			
Coleoptera	Gyrinidae	<i>Dineutus</i> sp.	whirligig beetle	PR	3.7								
Coleoptera	Hydrophilidae	<i>Berosus</i> sp.	scavenger beetle	PR	6.7								
Coleoptera	Psephenidae	<i>Ectopria nervosus</i>	false water penny	SC	5								
Coleoptera	Psephenidae	<i>Psephenus herricki</i>	water penny	SC	4								
Diptera	Athericidae	<i>Atherix</i> sp.	watersnipe fly	PR	4								
Diptera	Ceratopogonidae	<i>Palpomyia</i> gr.	biting midge	PR	6								
Diptera	Ceratopogonidae	<i>Probezzia</i> sp.	biting midge	PR	6								

Appendix C. Benthic Invertebrate Community Data - Grab Samples:
Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	RI-169-50-IC-SBB	RI-169-50-IC-SBC	RK-201-00-IC-SBA	RK-201-00-IC-SBB	RK-201-00-IC-SBC	RM-285-00-IC-SBA	RM-285-00-IC-SBB	RM-285-00-IC-SBC
Diptera	Chironomidae	<i>Ablabesmyia janta</i>	midge	OM	4.9								
Diptera	Chironomidae	<i>Ablabesmyia mallochii</i>	midge	OM	8								8
Diptera	Chironomidae	<i>Chironomini</i>	midge	GC	6								
Diptera	Chironomidae	<i>Chironomus sp.</i>	midge	GC	10		4		11	2		8	
Diptera	Chironomidae	<i>Cladotanytarsus sp.</i>	midge	GC	7								
Diptera	Chironomidae	<i>Corynoneura sp.</i>	midge	GC	7	8							
Diptera	Chironomidae	<i>Cricotopus bicintus</i>	midge	OM	6.7	120	92	26	9	10		44	148
Diptera	Chironomidae	<i>Cricotopus sp.</i>	midge	SH	7								
Diptera	Chironomidae	<i>Cricotopus trifasciata</i>	midge	OM	7								
Diptera	Chironomidae	<i>Cryptochironomus fulvus gr.</i>	midge	PR	8			2	1				
Diptera	Chironomidae	<i>Cryptotendipes sp.</i>	midge	GC	6								
Diptera	Chironomidae	<i>Dicrotendipes neomodestus</i>	midge	FG	4.5			18	5	2	12	8	4
Diptera	Chironomidae	<i>Endochironomus nigricans</i>	midge	SH	8								
Diptera	Chironomidae	<i>Eukiefferiella sp.</i>	midge	GC	4								
Diptera	Chironomidae	<i>Glyptotendipes sp.</i>	midge	FC	10								
Diptera	Chironomidae	<i>Microtendipes pedellus gr.</i>	midge	FG	6								
Diptera	Chironomidae	<i>Nanocladius sp.</i>	midge	GC	3								
Diptera	Chironomidae	<i>Orthocladius cplx.</i>	midge	GC	6	204	92	42	20	31	208	128	152
Diptera	Chironomidae	<i>Orthocladius sp.</i>	midge	GC	6								
Diptera	Chironomidae	<i>Paratanytarsus sp.</i>	midge	GC	6	4					24		
Diptera	Chironomidae	<i>Paratendipes basidens</i>	midge	GC	8		4						
Diptera	Chironomidae	<i>Pentaneura inconspicua</i>	midge	PR	4.9								
Diptera	Chironomidae	<i>Polypedilum flavum</i>	midge	SH	6	12	4			1	16	12	56
Diptera	Chironomidae	<i>Polypedilum sp.</i>	midge	SH	6								
Diptera	Chironomidae	<i>Polypedilum tritum</i>	midge	SH	6								
Diptera	Chironomidae	<i>Potthastia longimanna</i>	midge	GC	2								
Diptera	Chironomidae	<i>Procladius sp.</i>	midge	PR	9								
Diptera	Chironomidae	<i>Pseudochironomus sp.</i>	midge	GC	5		8	8	11	7			
Diptera	Chironomidae	<i>Rheotanytarsus sp.</i>	midge	FC	6	16	60		4	1	44	36	108
Diptera	Chironomidae	<i>Stictochironomus devinctus gr.</i>	midge	OM	5								
Diptera	Chironomidae	<i>Synorthocladius semivirens</i>	midge	GC	2.5								
Diptera	Chironomidae	<i>Tanytarsus sp.</i>	midge	FC	6		4			1			
Diptera	Chironomidae	<i>Thienemanniella xena</i>	midge	GC	3.6	12					8		12
Diptera	Chironomidae	<i>Thienemannimyia gr.</i>	midge	PR	6						4		4
Diptera	Chironomidae	<i>Tribelos jucundum</i>	midge	GC	5.6								
Diptera	Chironomidae	<i>Tvetenia vitracies</i>	midge	GC	5			2					
Diptera	Chironomidae	<i>Xenochironomus xenolabis</i>	midge	PR	0								
Diptera	Empididae	<i>Hemerodromia sp.</i>	dance fly	PR	6						2		
Diptera	Simuliidae	<i>Simulium sp.</i>	black fly	FC	4.8	4	12						
Diptera	Tabanidae	<i>Chrysops sp.</i>	deer fly	GC	6								
Diptera	Tipulidae	<i>Erioptera</i>	crane fly	GC	7								
<i>Metrics:</i>				# Filterers/Collectors		30	101	55	35	19	152	83	180
				Abundance		466	377	210	141	125	499	374	608
				Hilsenhoff Sum		2874.2	2409.1	1204.7	899	710	2730.6	2186	3527.6
				Mayfly Abundance		4	1	51	23	26	49	46	18
				Caddisfly Abundance		11	23	24	13	16	92	33	68
				Isopods, Snails, Leeches Abundance		12	11	3	1	1	12	17	2
				Surface Dependent Abundance		0	0	0	0	0	0	0	0
				Taxa Richness		27	28	32	24	25	28	31	29
				# of Mayfly Taxa		3	1	10	5	5	7	7	5
				# of Stonefly Taxa		0	1	1	0	1	1	1	1
				# of Caddisfly Taxa		5	4	6	4	4	4	5	5
				% Mayfly Comp		0.9	0.3	24.3	16.3	20.8	9.8	12.3	3.0
				% Caddisfly Comp		2.4	6.1	11.4	9.2	12.8	18.4	8.8	11.2
				% Dominant Taxon		43.8	24.4	20.0	14.2	24.8	41.7	34.2	25.0
				% Isopods, Snails, Leeches		2.6	2.9	1.4	0.7	0.8	2.4	4.5	0.3
				% Surface Dependent		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				HBI		6.17	6.39	5.74	6.38	5.68	5.47	5.84	5.80
				Ratio of Filterers-Collectors/Total		0.06	0.27	0.26	0.25	0.15	0.30	0.22	0.30
				EPT Index		8	6	17	9	10	12	13	11

Notes:
EPT Ephemeroptera, Plecoptera, and Trichoptera
FC Filterer/Collector
GC Gatherer/Collector
HBI Hilsenhoff Biotic Index
OM Omnivore
PA Parasite
PR Predator
SC Scraper
SH Shredder
Number
% Percent

Appendix D:
Benthic Invertebrate Community Data
Hester-Dendy

Appendix D. Benthic Invertebrate Community Data
Hester Dandy: Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	CR-REF-01-HD1	CR-REF-01-HD2	CR-REF-01-HD3	CR-REF-01-HD4	CR-REF-01-HD5	CR-REF-02-HD1	CR-REF-02-HD2	CR-REF-02-HD3	CR-REF-02-HD4	CR-REF-02-HD5	RA-003-50-HD1	RA-003-50-HD2	RA-003-50-HD3	RA-003-50-HD4	RA-003-50-HD5
Nematoda		spp 1	round worm	PA	9	2	3	3	1	1	1	3	1	12						
Tricladida	Planariidae	Dugesia tigrina	flat worm	PR	6									1	2			1	1	1
Hoplonemertea	Tetrastemmatidae	Prostoma graecense	proboscis worm	PR	8															
Hirudinea	Erpobdellidae	Mooreobdella microstoma	leech	PR	8															
Hirudinea	Glossiphoniidae	Helobdella elongata	leech	PR	8										1					
Hirudinea	Glossiphoniidae	Helobdella fusca	leech	PA	8															
Hirudinea	Glossiphoniidae	Helobdella stagnalis	leech	PR	8															
Tubificida	Naididae	Dero obtusa	naiad worm	GC	10							15	25	68						
Tubificida	Naididae	Nais bretscheri	naiad worm	GC	6															
Tubificida	Naididae	Nais sp.	naiad worm	GC	8	18	25	25		18	44	46	99	32	46	17	14	22	23	260
Tubificida	Naididae	Pristina longisoma	naiad worm	GC	9.9															
Tubificida	Naididae	Slavina appendiculata	naiad worm	GC	6															
Tubificida	Naididae	Stylaria lacustris	naiad worm	GC	6											2			1	
Tubificida	Enchytraeidae	spp 2	aquatic worm	GC	10															
Tubificida	Tubificidae	Branchiura sowerbyi	tube worm	GC	6												1			
Tubificida	Tubificidae	Limnodrilus hoffmeisteri	tube worm	GC	10															
Tubificida	Tubificidae	Limnodrilus sp.	tube worm	GC	10			5						32			4			
Hydroida	Hydridae	Hydra sp.	polyp	PR	5															
Basommatophora	Ancylidae	Ferrissia rivularis	limpet snail	SC	7				1		1		4	4	4		1	1	1	1
Basommatophora	Lymnaeidae	Fossaria sp.	pond snail	SC	2.6															
Basommatophora	Physidae	Physa sp.	pouch snail	SC	9			2		1				1	5	1	1			1
Basommatophora	Planorbidae	Gyraulus parvus	ram's horn snail	SC	5.5															
Basommatophora	Planorbidae	Helisoma sp.	ram's horn snail	SC	7										1	1				
Basommatophora	Hydrobiidae	Amnicola sp.	dusky snail	SC	4															
Mesogastropoda	Pleuroceridae	Goniobasis livescens	horn snail	SC	6															
Mesogastropoda	Pleuroceridae	Leptoxis carinata	horn snail	SC	6															
Veneroida	Dreissenidae	Dreissena polymorpha	zebra mussel	FC	8															1
Veneroida	Sphaeriidae	Pisidium sp.	pill clam	FC	4.6												1			
Hydracarina		spp 3	water mite	PR	6															
Amphipoda	Crangonyctidae	Crangonyx sp.	sideswimmer	GC	4															
Amphipoda	Gammaridae	Gammarus fasciatus	sideswimmer	GC	3	1		2	1					1	3	2	1	1	1	2
Amphipoda	Hyalellidae	Hyalella azteca	sideswimmer	GC	8	1				1	2			1	3		1		1	
Decapoda	Cambaridae	Orconectes sp.	crayfish	GC	5															
Isopoda	Asellidae	Caecidotea sp.	sowbug	GC	6					1										
Ephemeroptera	Baetidae	Acerpenna sp.	mayfly	SH	4						1				1			1		
Ephemeroptera	Baetidae	Baetis sp.	mayfly	GC	3.1	3	1								1					
Ephemeroptera	Baetidae	Centroptilum sp.	mayfly	GC	2															
Ephemeroptera	Baetidae	Plauditus sp.	mayfly	GC	4		1				2							1		
Ephemeroptera	Baetiscidae	Baetisca sp.	mayfly	GC	4							1	1						1	1
Ephemeroptera	Caenidae	Caenis sp.	mayfly	GC	7					1	1	1				1				
Ephemeroptera	Ephemeridae	Ephemera sp.	mayfly	CG	1															
Ephemeroptera	Ephemeridae	Hexagenia sp.	mayfly	GC	6								1							
Ephemeroptera	Ephemerellidae	Serratella sp.	mayfly	GC	0.6	1	1			2										
Ephemeroptera	Heptageniidae	Maccaffertium mediopunctatum	mayfly	SC	3	1	2	2	1			1	1							
Ephemeroptera	Heptageniidae	Maccaffertium sp.	mayfly	SC	4	13	21	13	2	8	11	14	4	14	14	3		5		5
Ephemeroptera	Heptageniidae	Stenacron interpunctatum	mayfly	OM	7					1	2		1	1	1	2		1	4	4
Ephemeroptera	Heptageniidae	Stenonema femoratum	mayfly	OM	5															
Ephemeroptera	Isonychiidae	Isonychia sp.	mayfly	FC	2		1			2	10		1	7						
Ephemeroptera	Leptophlebiidae	Leptophlebia sp.	mayfly	GC	4	1	2	4		3	6	1	3	3	13	10	5	3	3	3
Ephemeroptera	Potamanthidae	Anthopotamus verticis gr.	mayfly	GC	3.2	2				2		1		2			1			
Ephemeroptera	Tricorythidae	Tricorythodes sp.	mayfly	GC	4	9	4	8	3	6	2		2	2						
Odonata	Aeshnidae	Boyeria vinosa	dragonfly	PR	3.5															
Odonata	Calopterygidae	Haeterina sp.	damselfly	PR	6		1				2									
Odonata	Coenagrionidae	Argia sp.	damselfly	PR	5.1						1	1				3				
Odonata	Coenagrionidae	Enallagma sp.	damselfly	PR	9	1	1	1	1					3	2	4	2	4	1	1
Odonata	Corduliidae	Neurocordulia sp.	dragonfly	PR	3															
Odonata	Gomphidae	spp 4	dragonfly	PR	4															
Odonata	Gomphidae	Gomphus sp.	dragonfly	PR	5															
Plecoptera	Capniidae	Allocapnia sp.	stonefly	SH	3	3	5	1		2		4	5	4		2		3	2	3
Plecoptera	Chloroperlidae	Haploperla brevis	stonefly	PR	1															
Plecoptera	Perlidae	Acroneuria sp.	stonefly	PR	1			1		2	2	1		3				1		
Plecoptera	Taeniopterygidae	Taeniopteryx sp.	stonefly	SH	2	17	29	10	7	8	7	10	7	4	6	1	3	1	1	3
Megaloptera	Sialidae	Sialis sp.	alderfly	PR	4															
Hemiptera	Belostomatidae	Belostoma lutarium	giant water bug	PR	9															
Hemiptera	Corixidae	Sigara lineata	water boatmen	GC	8															
Trichoptera	Brachycentridae	Brachycentrus sp.	caddisfly	FC	1	1	2						1	1						
Trichoptera	Glossosomatidae	Protoptila sp.	caddisfly	SC	1		1								1					
Trichoptera	Helicopsychidae	Helicopsyche borealis	caddisfly	SC	3	1														
Trichoptera	Hydropsychidae	Cheumatopsyche sp.	caddisfly	FC	5	6	29	6	1	5	2	1	3	3	2		1			1
Trichoptera	Hydropsychidae	Hydropsyche aerata	caddisfly	FC	2.6		1													

Appendix D. Benthic Invertebrate Community Data
Hester Dandy: Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	RB-012-50-HD1	RB-012-50-HD2	RB-012-50-HD3	RB-012-50-HD4	RB-012-50-HD5	RE-061-00-HD1	RE-061-00-HD2	RE-061-00-HD3	RE-061-00-HD4	RE-061-00-HD5	RE-062-00-HD1	RE-062-00-HD2	RE-062-00-HD3	RE-062-00-HD4	RE-062-00-HD5
Nematoda		spp 1	round worm	PA	9															
Tricladida	Planariidae	Dugesia tigrina	flat worm	PR	6	1	1		2		2			2	4	1	1		1	3
Hoplonemertea	Tetrastemmatidae	Prostoma graecense	proboscis worm	PR	8						4	4	1	8	12			2		
Hirudinea	Erpobdellidae	Mooreobdella microstoma	leech	PR	8															
Hirudinea	Glossiphoniidae	Helobdella elongata	leech	PR	8															
Hirudinea	Glossiphoniidae	Helobdella fusca	leech	PA	8															
Hirudinea	Glossiphoniidae	Helobdella stagnalis	leech	PR	8															
Tubificida	Naididae	Dero obtusa	naiad worm	GC	10															
Tubificida	Naididae	Nais bretscheri	naiad worm	GC	6															
Tubificida	Naididae	Nais sp.	naiad worm	GC	8	84	88	196	104	144	96	140	21	88	52	10	12		40	
Tubificida	Naididae	Pristina longisoma	naiad worm	GC	9.9															
Tubificida	Naididae	Slavina appendiculata	naiad worm	GC	6															
Tubificida	Naididae	Stylaria lacustris	naiad worm	GC	6		4			8			1							
Tubificida	Enchytraeidae	spp 2	aquatic worm	GC	10															
Tubificida	Tubificidae	Branchiura sowerbyi	tube worm	GC	6								1							
Tubificida	Tubificidae	Limnodrilus hoffmeisteri	tube worm	GC	10															
Tubificida	Tubificidae	Limnodrilus sp.	tube worm	GC	10															
Hydroida	Hydridae	Hydra sp.	polyp	PR	5															
Basommatophora	Ancylidae	Ferrissia rivularis	limpet snail	SC	7	16	1	1	4	2			3	2	3	1		5	2	1
Basommatophora	Lymnaeidae	Fossaria sp.	pond snail	SC	2.6	1		9	3											
Basommatophora	Physidae	Physa sp.	pouch snail	SC	9		2	1	1		1	1		1		1	1	1	1	1
Basommatophora	Planorbidae	Gyraulus parvus	ram's horn snail	SC	5.5															
Basommatophora	Planorbidae	Helisoma sp.	ram's horn snail	SC	7				1	2					1				1	
Basommatophora	Hydrobiidae	Amnicola sp.	dusky snail	SC	4															
Mesogastropoda	Pleuroceridae	Goniobasis livescens	horn snail	SC	6															
Mesogastropoda	Pleuroceridae	Leptoxis carinata	horn snail	SC	6															
Veneroida	Dreissenidae	Dreissena polymorpha	zebra mussel	FC	8			1			2	2		1	1		2			
Veneroida	Sphaeriidae	Pisidium sp.	pill clam	FC	4.6															
Hydracarina		spp 3	water mite	PR	6															
Amphipoda	Crangonyctidae	Crangonyx sp.	sideswimmer	GC	4								2							1
Amphipoda	Gammaridae	Gammarus fasciatus	sideswimmer	GC	3	23	14	10	24	88	3	6	1	3	4	12	16	9	14	7
Amphipoda	Hyalellidae	Hyalella azteca	sideswimmer	GC	8		2													
Decapoda	Cambaridae	Orconectes sp.	crayfish	GC	5															
Isopoda	Asellidae	Caecidotea sp.	sowbug	GC	6			1												
Ephemeroptera	Baetidae	Acerpenna sp.	mayfly	SH	4		1													2
Ephemeroptera	Baetidae	Baetis sp.	mayfly	GC	3.1															
Ephemeroptera	Baetidae	Centroptilum sp.	mayfly	GC	2															
Ephemeroptera	Baetidae	Plauditus sp.	mayfly	GC	4											1				
Ephemeroptera	Baetiscidae	Baetisca sp.	mayfly	GC	4			1										1		
Ephemeroptera	Caenidae	Caenis sp.	mayfly	GC	7		1										1			
Ephemeroptera	Ephemeridae	Ephemera sp.	mayfly	CG	1								1							
Ephemeroptera	Ephemeridae	Hexagenia sp.	mayfly	GC	6															
Ephemeroptera	Serratellidae	Serratella sp.	mayfly	GC	0.6						1									1
Ephemeroptera	Heptageniidae	Maccaffertium mediopunctatum	mayfly	SC	3													2		
Ephemeroptera	Heptageniidae	Maccaffertium sp.	mayfly	SC	4		2			1	8	4		1	1	11	34	8	14	6
Ephemeroptera	Heptageniidae	Stenacron interpunctatum	mayfly	OM	7	2		2	1		1							2	3	
Ephemeroptera	Heptageniidae	Stenonema femoratum	mayfly	OM	5															
Ephemeroptera	Isonychiidae	Isonychia sp.	mayfly	FC	2											1	3	4	1	
Ephemeroptera	Leptophlebiidae	Leptophlebia sp.	mayfly	GC	4			1	1			1			4	5	8	1	3	1
Ephemeroptera	Potamanthidae	Anthopotamus verticis gr.	mayfly	GC	3.2	1				2	1						1	1		
Ephemeroptera	Tricorythidae	Tricorythodes sp.	mayfly	GC	4						2	7		2	3	11	18	23	13	1
Odonata	Aeshnidae	Boyeria vinosa	dragonfly	PR	3.5	1														
Odonata	Calopterygidae	Haeterina sp.	damselfly	PR	6												1			2
Odonata	Coenagrionidae	Argia sp.	damselfly	PR	5.1												1			1
Odonata	Coenagrionidae	Enallagma sp.	damselfly	PR	9	2		2	2	2	1	3		1	1	5	10	8	2	10
Odonata	Corduliidae	Neurocordulia sp.	dragonfly	PR	3															
Odonata	Gomphidae	spp 4	dragonfly	PR	4															
Odonata	Gomphidae	Gomphus sp.	dragonfly	PR	5															
Plecoptera	Capniidae	Allocapnia sp.	stonefly	SH	3						3	4				32	4	13	28	3
Plecoptera	Chloroperlidae	Haploperla brevis	stonefly	PR	1															
Plecoptera	Perlidae	Acroneuria sp.	stonefly	PR	1									8		8	1			1
Plecoptera	Taeniopterygidae	Taeniopteryx sp.	stonefly	SH	2					3	33	28	1	6	4	192	57	168	144	36
Megaloptera	Sialidae	Sialis sp.	alderfly	PR	4															
Hemiptera	Belostomatidae	Belostoma lutarium	giant water bug	PR	9												1			
Hemiptera	Corixidae	Sigara lineata	water boatmen	GC	8	1														
Trichoptera	Brachycentridae	Brachycentrus sp.	caddisfly	FC	1		1			2						2	7	2	1	1
Trichoptera	Glossosomatidae	Protoptila sp.	caddisfly	SC	1												1			
Trichoptera	Helicopsychidae	Helicopsyche borealis	caddisfly	SC	3															
Trichoptera	Hydropsychidae	Cheumatopsyche sp.	caddisfly	FC	5					2	33	49	8	49	32	54	85	22	38	20
Trichoptera	Hydropsychidae	Hydropsyche aerata	caddisfly	FC	2.6						2	2		1	1		2	1	1	2

Appendix D. Benthic Invertebrate Community Data
Hester Dandy: Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	RE-073-00-HD1	RE-073-00-HD2	RE-073-00-HD5	RF-082-00-HD1	RF-082-00-HD2	RF-082-00-HD3	RF-082-00-HD4	RF-082-00-HD5	RG-136-00-HD1	RG-136-00-HD2	RG-136-00-HD3	RG-136-00-HD4	RG-136-00-HD5	RG-137-50-HD1	RG-137-50-HD2
Nematoda		spp 1	round worm	PA	9		1						1	4	4		4		4	
Tricladida	Planariidae	Dugesia tigrina	flat worm	PR	6	3	9	5	24	5	8							1	5	1
Hoplonemertea	Tetrastemmatidae	Prostoma graecense	proboscis worm	PR	8	4			16	4	2		1	4			4	4		
Hirudinea	Erpobdellidae	Mooreobdella microstoma	leech	PR	8															
Hirudinea	Glossiphoniidae	Helobdella elongata	leech	PR	8															
Hirudinea	Glossiphoniidae	Helobdella fusca	leech	PA	8															
Hirudinea	Glossiphoniidae	Helobdella stagnalis	leech	PR	8															
Tubificida	Naididae	Dero obtusa	naiad worm	GC	10		28													
Tubificida	Naididae	Nais bretscheri	naiad worm	GC	6	20		24	40	11	8	24					40		68	176
Tubificida	Naididae	Nais sp.	naiad worm	GC	8	184	348	232	164	43	42	108	32	116	164	268	132	112	212	536
Tubificida	Naididae	Pristina longisoma	naiad worm	GC	9.9															
Tubificida	Naididae	Slavina appendiculata	naiad worm	GC	6		8													
Tubificida	Naididae	Stylaria lacustris	naiad worm	GC	6	8	52													
Tubificida	Enchytraeidae	spp 2	aquatic worm	GC	10												8			
Tubificida	Tubificidae	Branchiura sowerbyi	tube worm	GC	6															
Tubificida	Tubificidae	Limnodrilus hoffmeisteri	tube worm	GC	10															
Tubificida	Tubificidae	Limnodrilus sp.	tube worm	GC	10		48													
Hydroida	Hydridae	Hydra sp.	polyp	PR	5		2													
Basommatophora	Ancylidae	Ferrissia rivularis	limpet snail	SC	7	1	1	1	9			1	1	10	3		29	11	1	
Basommatophora	Lymnaeidae	Fossaria sp.	pond snail	SC	2.6															
Basommatophora	Physidae	Physa sp.	pouch snail	SC	9									5	9	7	6	7		
Basommatophora	Planorbidae	Gyraulus parvus	ram's horn snail	SC	5.5															
Basommatophora	Planorbidae	Helisoma sp.	ram's horn snail	SC	7															
Basommatophora	Hydrobiidae	Amnicola sp.	dusky snail	SC	4															
Mesogastropoda	Pleuroceridae	Goniobasis livescens	horn snail	SC	6															
Mesogastropoda	Pleuroceridae	Leptoxis carinata	horn snail	SC	6															
Veneroida	Dreissenidae	Dreissena polymorpha	zebra mussel	FC	8															1
Veneroida	Sphaeriidae	Pisidium sp.	pill clam	FC	4.6															
Hydracarina		spp 3	water mite	PR	6					1								1		
Amphipoda	Crangonyctidae	Crangonyx sp.	sideswimmer	GC	4															
Amphipoda	Gammaridae	Gammarus fasciatus	sideswimmer	GC	3	1		1	1	1		2	2	2	1	4	1		3	2
Amphipoda	Hyalellidae	Hyalella azteca	sideswimmer	GC	8			1		1						1				
Decapoda	Cambaridae	Orconectes sp.	crayfish	GC	5															
Isopoda	Asellidae	Caecidotea sp.	sowbug	GC	6		1													
Ephemeroptera	Baetidae	Acerpenna sp.	mayfly	SH	4															
Ephemeroptera	Baetidae	Baetis sp.	mayfly	GC	3.1															
Ephemeroptera	Baetidae	Centroptilum sp.	mayfly	GC	2															
Ephemeroptera	Baetidae	Plauditus sp.	mayfly	GC	4									1		2				
Ephemeroptera	Baetiscidae	Baetisca sp.	mayfly	GC	4										1					
Ephemeroptera	Caenidae	Caenis sp.	mayfly	GC	7								3							
Ephemeroptera	Ephemeridae	Ephemera sp.	mayfly	CG	1															
Ephemeroptera	Ephemeridae	Hexagenia sp.	mayfly	GC	6															
Ephemeroptera	Ephemerellidae	Serratella sp.	mayfly	GC	0.6															
Ephemeroptera	Heptageniidae	Maccaffertium mediopunctatum	mayfly	SC	3															
Ephemeroptera	Heptageniidae	Maccaffertium sp.	mayfly	SC	4	1	2	2		1			7	8	13	27	5	6	10	15
Ephemeroptera	Heptageniidae	Stenacron interpunctatum	mayfly	OM	7			1									1	1	1	
Ephemeroptera	Heptageniidae	Stenonema femoratum	mayfly	OM	5															
Ephemeroptera	Isonychiidae	Isonychia sp.	mayfly	FC	2								1	2	4	4		1		2
Ephemeroptera	Leptophlebiidae	Leptophlebia sp.	mayfly	GC	4			1				1	3	1		3	3		3	
Ephemeroptera	Potamanthidae	Anthopotamus verticis gr.	mayfly	GC	3.2				1							2				1
Ephemeroptera	Tricorythidae	Tricorythodes sp.	mayfly	GC	4			2						17	22	18	6	3		
Odonata	Aeshnidae	Boyeria vinosa	dragonfly	PR	3.5															
Odonata	Calopterygidae	Haeterina sp.	damselfly	PR	6									1	1					
Odonata	Coenagrionidae	Argia sp.	damselfly	PR	5.1		1		1											
Odonata	Coenagrionidae	Enallagma sp.	damselfly	PR	9			1	1	1	1	1	2		2		1		1	1
Odonata	Corduliidae	Neurocordulia sp.	dragonfly	PR	3															
Odonata	Gomphidae	spp 4	dragonfly	PR	4											1				
Odonata	Gomphidae	Gomphus sp.	dragonfly	PR	5															
Plecoptera	Capniidae	Allocapnia sp.	stonefly	SH	3		1		3	2	1					12	8		2	2
Plecoptera	Chloroperlidae	Haploperla brevis	stonefly	PR	1															
Plecoptera	Perlidae	Acroneuria sp.	stonefly	PR	1										8					
Plecoptera	Taeniopterygidae	Taeniopteryx sp.	stonefly	SH	2	1		6		8	4	1	42	203	208	397	144	116	23	34
Megaloptera	Sialidae	Sialis sp.	alderfly	PR	4															
Hemiptera	Belostomatidae	Belostoma lutarium	giant water bug	PR	9															
Hemiptera	Corixidae	Sigara lineata	water boatmen	GC	8															
Trichoptera	Brachycentridae	Brachycentrus sp.	caddisfly	FC	1								3	4		7	2	1	1	1
Trichoptera	Glossosomatidae	Protoptila sp.	caddisfly	SC	1															
Trichoptera	Helicopsychidae	Helicopsyche borealis	caddisfly	SC	3												1			
Trichoptera	Hydropsychidae	Cheumatopsyche sp.	caddisfly	FC	5	1	1	3			3	1	41	24	44	71	6	8	28	13
Trichoptera	Hydropsychidae	Hydropsyche aerata	caddisfly	FC	2.6															

Appendix D. Benthic Invertebrate Community Data
Hester Dandy: Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	RG-137-50-HD3	RG-137-50-HD4	RG-137-50-HD5	RH-143-00-HD1	RH-143-00-HD2	RH-143-00-HD3	RH-144-50-HD1	RH-144-50-HD2	RH-144-50-HD3	RH-144-50-HD4	RH-144-50-HD5	RH-150-00-HD1	RH-150-00-HD2	RH-150-00-HD3	RH-150-00-HD4
Nematoda		spp 1	round worm	PA	9						1			8			4		4	
Tricladida	Planariidae	Dugesia tigrina	flat worm	PR	6	3		3			1									
Hoplonemertea	Tetrastemmatidae	Prostoma graecense	proboscis worm	PR	8									8		8				
Hirudinea	Erpobdellidae	Mooreobdella microstoma	leech	PR	8															
Hirudinea	Glossiphoniidae	Helobdella elongata	leech	PR	8															
Hirudinea	Glossiphoniidae	Helobdella fusca	leech	PA	8															
Hirudinea	Glossiphoniidae	Helobdella stagnalis	leech	PR	8															
Tubificida	Naididae	Dero obtusa	naiad worm	GC	10															
Tubificida	Naididae	Nais bretscheri	naiad worm	GC	6		40		28		32		48	104						
Tubificida	Naididae	Nais sp.	naiad worm	GC	8	472	456	344	232	388	468	444	376	512	384	280	244	344	388	384
Tubificida	Naididae	Pristina longisoma	naiad worm	GC	9.9															
Tubificida	Naididae	Slavina appendiculata	naiad worm	GC	6															
Tubificida	Naididae	Stylaria lacustris	naiad worm	GC	6															
Tubificida	Enchytraeidae	spp 2	aquatic worm	GC	10															
Tubificida	Tubificidae	Branchiura sowerbyi	tube worm	GC	6															
Tubificida	Tubificidae	Limnodrilus hoffmeisteri	tube worm	GC	10															
Tubificida	Tubificidae	Limnodrilus sp.	tube worm	GC	10												12	20		
Hydroida	Hydridae	Hydra sp.	polyp	PR	5															
Basommatophora	Ancylidae	Ferrissia rivularis	limpet snail	SC	7		2			1	1			1		2		1	1	1
Basommatophora	Lymnaeidae	Fossaria sp.	pond snail	SC	2.6															
Basommatophora	Physidae	Physa sp.	pouch snail	SC	9															
Basommatophora	Planorbidae	Gyraulus parvus	ram's horn snail	SC	5.5															
Basommatophora	Planorbidae	Helisoma sp.	ram's horn snail	SC	7															
Basommatophora	Hydrobiidae	Amnicola sp.	dusky snail	SC	4															
Mesogastropoda	Pleuroceridae	Goniobasis livescens	horn snail	SC	6	1	2	7		1										1
Mesogastropoda	Pleuroceridae	Leptoxis carinata	horn snail	SC	6															
Veneroida	Dreissenidae	Dreissena polymorpha	zebra mussel	FC	8						1									
Veneroida	Sphaeriidae	Pisidium sp.	pill clam	FC	4.6															
Hydracarina		spp 3	water mite	PR	6			1									1	1		
Amphipoda	Crangonyctidae	Crangonyx sp.	sideswimmer	GC	4											1				
Amphipoda	Gammaridae	Gammarus fasciatus	sideswimmer	GC	3					1								5	2	
Amphipoda	Hyalellidae	Hyalella azteca	sideswimmer	GC	8															
Decapoda	Cambaridae	Orconectes sp.	crayfish	GC	5															
Isopoda	Asellidae	Caecidotea sp.	sowbug	GC	6						1									
Ephemeroptera	Baetidae	Acerpenna sp.	mayfly	SH	4						1					2				
Ephemeroptera	Baetidae	Baetis sp.	mayfly	GC	3.1															
Ephemeroptera	Baetidae	Centroptilum sp.	mayfly	GC	2															
Ephemeroptera	Baetidae	Plauditus sp.	mayfly	GC	4	1	1		1							1				
Ephemeroptera	Baetiscidae	Baetisca sp.	mayfly	GC	4			1												
Ephemeroptera	Caenidae	Caenis sp.	mayfly	GC	7		1			1			1					1		
Ephemeroptera	Ephemeridae	Ephemera sp.	mayfly	CG	1															
Ephemeroptera	Ephemeridae	Hexagenia sp.	mayfly	GC	6															
Ephemeroptera	Ephemerellidae	Serratella sp.	mayfly	GC	0.6															
Ephemeroptera	Heptageniidae	Maccaffertium mediopunctatum	mayfly	SC	3															
Ephemeroptera	Heptageniidae	Maccaffertium sp.	mayfly	SC	4	25	13	28	9	8	17	15	23	13	10	8		3	4	4
Ephemeroptera	Heptageniidae	Stenacron interpunctatum	mayfly	OM	7	2		1	1	3	1									
Ephemeroptera	Heptageniidae	Stenonema femoratum	mayfly	OM	5												1		3	
Ephemeroptera	Isonychiidae	Isonychia sp.	mayfly	FC	2		1	1	1	1	3	1	2		1					
Ephemeroptera	Leptophlebiidae	Leptophlebia sp.	mayfly	GC	4	1		2			1	7	5	17	16	13	1	3	5	4
Ephemeroptera	Potamanthidae	Anthopotamus verticis gr.	mayfly	GC	3.2								1							
Ephemeroptera	Tricorythidae	Tricorythodes sp.	mayfly	GC	4		1	2	3	2	9	1	2		5	2		1	1	4
Odonata	Aeshnidae	Boyeria vinosa	dragonfly	PR	3.5															
Odonata	Calopterygidae	Haeterina sp.	damselfly	PR	6					1				2						
Odonata	Coenagrionidae	Argia sp.	damselfly	PR	5.1										1					1
Odonata	Coenagrionidae	Enallagma sp.	damselfly	PR	9						2				3	3		1		1
Odonata	Corduliidae	Neurocordulia sp.	dragonfly	PR	3															
Odonata	Gomphidae	spp 4	dragonfly	PR	4															
Odonata	Gomphidae	Gomphus sp.	dragonfly	PR	5															
Plecoptera	Capniidae	Allocapnia sp.	stonefly	SH	3	1	3	3		1		3		1	2	1		1	1	
Plecoptera	Chloroperlidae	Haploperla brevis	stonefly	PR	1															
Plecoptera	Perlidae	Acroneuria sp.	stonefly	PR	1				4											
Plecoptera	Taeniopterygidae	Taeniopteryx sp.	stonefly	SH	2	57	43	24	112	50	49	53	98	43	130	157	4	6	21	21
Megaloptera	Sialidae	Sialis sp.	alderfly	PR	4															
Hemiptera	Belostomatidae	Belostoma lutarium	giant water bug	PR	9															
Hemiptera	Corixidae	Sigara lineata	water boatmen	GC	8															
Trichoptera	Brachycentridae	Brachycentrus sp.	caddisfly	FC	1		2	2	4	3				1		2				1
Trichoptera	Glossosomatidae	Protoptila sp.	caddisfly	SC	1															
Trichoptera	Helicopsychidae	Helicopsyche borealis	caddisfly	SC	3															
Trichoptera	Hydropsychidae	Cheumatopsyche sp.	caddisfly	FC	5	4	17	3	13	24	29	6	28	1	9	14				
Trichoptera	Hydropsychidae	Hydropsyche aerata	caddisfly	FC	2.6				1											

Appendix D. Benthic Invertebrate Community Data
Hester Dandy: Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	RH-150-00-HD5	RI-164-00-HD1	RI-164-00-HD2	RI-164-00-HD3	RI-164-00-HD4	RI-164-00-HD5	RI-164-50-HD1	RI-164-50-HD2	RI-164-50-HD3	RI-164-50-HD4	RI-164-50-HD5	RI-168-50-HD1	RI-168-50-HD2	RI-168-50-HD3	RI-168-50-HD4
Nematoda		spp 1	round worm	PA	9					1	3			4						
Tricladida	Planariidae	Dugesia tigrina	flat worm	PR	6	1								1		1	8	25	10	10
Hoplonemertea	Tetrastemmatidae	Prostoma graecense	proboscis worm	PR	8															
Hirudinea	Erpobdellidae	Mooreobdella microstoma	leech	PR	8									2		1		1	1	
Hirudinea	Glossiphoniidae	Helobdella elongata	leech	PR	8															
Hirudinea	Glossiphoniidae	Helobdella fusca	leech	PA	8	1														
Hirudinea	Glossiphoniidae	Helobdella stagnalis	leech	PR	8							1	5	2	2				3	
Tubificida	Naididae	Dero obtusa	naiad worm	GC	10															
Tubificida	Naididae	Nais bretscheri	naiad worm	GC	6	52	16	52	72							24				
Tubificida	Naididae	Nais sp.	naiad worm	GC	8	416	408	504	968	76	51	368	388	432	344	324	137	380	116	116
Tubificida	Naididae	Pristina longisoma	naiad worm	GC	9.9															
Tubificida	Naididae	Slavina appendiculata	naiad worm	GC	6															
Tubificida	Naididae	Stylaria lacustris	naiad worm	GC	6															
Tubificida	Enchytraeidae	spp 2	aquatic worm	GC	10					1							4			
Tubificida	Tubificidae	Branchiura sowerbyi	tube worm	GC	6															
Tubificida	Tubificidae	Limnodrilus hoffmeisteri	tube worm	GC	10															
Tubificida	Tubificidae	Limnodrilus sp.	tube worm	GC	10							28	40	8		12				
Hydroida	Hydridae	Hydra sp.	polyp	PR	5															
Basommatophora	Ancylidae	Ferrissia rivularis	limpet snail	SC	7							1					8	6	5	
Basommatophora	Lymnaeidae	Fossaria sp.	pond snail	SC	2.6														1	
Basommatophora	Physidae	Physa sp.	pouch snail	SC	9							1	1					2	1	
Basommatophora	Planorbidae	Gyraulus parvus	ram's horn snail	SC	5.5															
Basommatophora	Planorbidae	Helisoma sp.	ram's horn snail	SC	7							1	1			1				
Basommatophora	Hydrobiidae	Amnicola sp.	dusky snail	SC	4															
Mesogastropoda	Pleuroceridae	Goniobasis livescens	horn snail	SC	6	3							1				4	3	13	15
Mesogastropoda	Pleuroceridae	Leptoxis carinata	horn snail	SC	6															
Veneroida	Dreissenidae	Dreissena polymorpha	zebra mussel	FC	8							1	1							
Veneroida	Sphaeriidae	Pisidium sp.	pill clam	FC	4.6															
Hydracarina		spp 3	water mite	PR	6											1				
Amphipoda	Crangonyctidae	Crangonyx sp.	sideswimmer	GC	4							1		2						
Amphipoda	Gammaridae	Gammarus fasciatus	sideswimmer	GC	3	2								1			1			1
Amphipoda	Hyalellidae	Hyalella azteca	sideswimmer	GC	8															
Decapoda	Cambaridae	Orconectes sp.	crayfish	GC	5															
Isopoda	Asellidae	Caecidotea sp.	sowbug	GC	6								5	5	2	5	2	2	9	
Ephemeroptera	Baetidae	Acerpenna sp.	mayfly	SH	4		3		2											
Ephemeroptera	Baetidae	Baetis sp.	mayfly	GC	3.1															
Ephemeroptera	Baetidae	Centroptilum sp.	mayfly	GC	2															
Ephemeroptera	Baetidae	Plauditus sp.	mayfly	GC	4															
Ephemeroptera	Baetiscidae	Baetisca sp.	mayfly	GC	4			1												
Ephemeroptera	Caenidae	Caenis sp.	mayfly	GC	7					1		1								
Ephemeroptera	Ephemeridae	Ephemera sp.	mayfly	CG	1															
Ephemeroptera	Ephemeridae	Hexagenia sp.	mayfly	GC	6															
Ephemeroptera	Ephemerellidae	Serratella sp.	mayfly	GC	0.6				1											
Ephemeroptera	Heptageniidae	Maccaffertium mediopunctatum	mayfly	SC	3															
Ephemeroptera	Heptageniidae	Maccaffertium sp.	mayfly	SC	4	15	7	9	16	3	4				1		2	3	1	2
Ephemeroptera	Heptageniidae	Stenacron interpunctatum	mayfly	OM	7	1	1		2	1			1				1			
Ephemeroptera	Heptageniidae	Stenonema femoratum	mayfly	OM	5															
Ephemeroptera	Isonychiidae	Isonychia sp.	mayfly	FC	2				2			1		1				3		1
Ephemeroptera	Leptophlebiidae	Leptophlebia sp.	mayfly	GC	4	2	2	1	3				1							
Ephemeroptera	Potamanthidae	Anthopotamus verticis gr.	mayfly	GC	3.2				1	1										
Ephemeroptera	Tricorythidae	Tricorythodes sp.	mayfly	GC	4				5	2	1								1	
Odonata	Aeshnidae	Boyeria vinosa	dragonfly	PR	3.5															
Odonata	Calopterygidae	Haeterina sp.	damselfly	PR	6											1	2		1	
Odonata	Coenagrionidae	Argia sp.	damselfly	PR	5.1							3							1	
Odonata	Coenagrionidae	Enallagma sp.	damselfly	PR	9			1	1			16	11	6	9	14	6	3	9	7
Odonata	Corduliidae	Neurocordulia sp.	dragonfly	PR	3															
Odonata	Gomphidae	spp 4	dragonfly	PR	4															
Odonata	Gomphidae	Gomphus sp.	dragonfly	PR	5															
Plecoptera	Capniidae	Allocapnia sp.	stonefly	SH	3			1												
Plecoptera	Chloroperlidae	Haploperla brevis	stonefly	PR	1													1		
Plecoptera	Perlidae	Acroneuria sp.	stonefly	PR	1															
Plecoptera	Taeniopterygidae	Taeniopteryx sp.	stonefly	SH	2	20	18	9	52	9	12			2	8		1		2	1
Megaloptera	Sialidae	Sialis sp.	alderfly	PR	4															
Hemiptera	Belostomatidae	Belostoma lutarium	giant water bug	PR	9															
Hemiptera	Corixidae	Sigara lineata	water boatmen	GC	8															
Trichoptera	Brachycentridae	Brachycentrus sp.	caddisfly	FC	1				2	1									1	6
Trichoptera	Glossosomatidae	Protoptila sp.	caddisfly	SC	1															
Trichoptera	Helicopsychidae	Helicopsyche borealis	caddisfly	SC	3															
Trichoptera	Hydropsychidae	Cheumatopsyche sp.	caddisfly	FC	5	10	4	9	42	10	6			1			13	9	11	17
Trichoptera	Hydropsychidae	Hydropsyche aerata	caddisfly	FC	2.6	1			2											

Appendix D. Benthic Invertebrate Community Data
Hester Dandy: Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	RI-168-50-HD5	RK-201-00-HD1	RK-201-00-HD2	RK-201-00-HD3	RK-201-00-HD4	RK-201-00-HD5	RM-285-00-HD1	RM-285-00-HD2	RM-285-00-HD3	RM-285-00-HD4	RM-285-00-HD5	TR-REF-01-HD1	TR-REF-01-HD2	TR-REF-01-HD3	TR-REF-01-HD4
Nematoda		spp 1	round worm	PA	9		3	0	1	0	4	1	0	1	0	1	0	0	0	0
Tricladida	Planariidae	Dugesia tigrina	flat worm	PR	6	52	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Hoplonemertea	Tetrastemmatidae	Prostoma graecense	proboscis worm	PR	8		0	0	0	0	0	0	0	1	0	0	0	0	0	0
Hirudinea	Erpobdellidae	Mooreobdella microstoma	leech	PR	8															
Hirudinea	Glossiphoniidae	Helobdella elongata	leech	PR	8		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hirudinea	Glossiphoniidae	Helobdella fusca	leech	PA	8		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hirudinea	Glossiphoniidae	Helobdella stagnalis	leech	PR	8		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tubificida	Naididae	Dero obtusa	naiad worm	GC	10		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tubificida	Naididae	Nais bretscheri	naiad worm	GC	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tubificida	Naididae	Nais sp.	naiad worm	GC	8	189	15	88	47	55	94	92	128	29	132	43	4	0	4	2
Tubificida	Naididae	Pristina longisoma	naiad worm	GC	9.9		0	0	0	0	0	0	0	0	0	0	0	0	1	0
Tubificida	Naididae	Slavina appendiculata	naiad worm	GC	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tubificida	Naididae	Stylaria lacustris	naiad worm	GC	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tubificida	Enchytraeidae	spp 2	aquatic worm	GC	10		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tubificida	Tubificidae	Branchiura sowerbyi	tube worm	GC	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tubificida	Tubificidae	Limnodrilus hoffmeisteri	tube worm	GC	10		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tubificida	Tubificidae	Limnodrilus sp.	tube worm	GC	10		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydroida	Hydridae	Hydra sp.	polyp	PR	5		0	0	0	0	0	0	0	0	0	0	1	18	6	1
Basommatophora	Ancylidae	Ferrissia rivularis	limpet snail	SC	7	1	0	0	0	0	0	0	0	0	0	0	1	2	0	2
Basommatophora	Lymnaeidae	Fossaria sp.	pond snail	SC	2.6		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Basommatophora	Physidae	Physa sp.	pouch snail	SC	9		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Basommatophora	Planorbidae	Gyraulus parvus	ram's horn snail	SC	5.5		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Basommatophora	Planorbidae	Helisoma sp.	ram's horn snail	SC	7		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Basommatophora	Hydrobiidae	Amnicola sp.	dusky snail	SC	4		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mesogastropoda	Pleuroceridae	Goniobasis livescens	horn snail	SC	6	12	0	0	0	0	0	0	0	0	1	0	1	1	1	2
Mesogastropoda	Pleuroceridae	Leptoxis carinata	horn snail	SC	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Veneroida	Dreissenidae	Dreissena polymorpha	zebra mussel	FC	8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Veneroida	Sphaeriidae	Pisidium sp.	pill clam	FC	4.6		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydracarina		spp 3	water mite	PR	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Amphipoda	Crangonyctidae	Crangonyx sp.	sideswimmer	GC	4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Amphipoda	Gammaridae	Gammarus fasciatus	sideswimmer	GC	3		0	0	0	0	0	0	0	0	0	0	48	72	37	33
Amphipoda	Hyalellidae	Hyalella azteca	sideswimmer	GC	8		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Decapoda	Cambaridae	Orconectes sp.	crayfish	GC	5		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isopoda	Asellidae	Caecidotea sp.	sowbug	GC	6	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemeroptera	Baetidae	Acerpenna sp.	mayfly	SH	4		0	0	1	0	0	0	0	0	0	0	0	0	0	0
Ephemeroptera	Baetidae	Baetis sp.	mayfly	GC	3.1		0	0	0	0	0	0	0	0	0	1	0	0	0	0
Ephemeroptera	Baetidae	Centroptilum sp.	mayfly	GC	2		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemeroptera	Baetidae	Plauditus sp.	mayfly	GC	4		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemeroptera	Baetiscidae	Baetisca sp.	mayfly	GC	4		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemeroptera	Caenidae	Caenis sp.	mayfly	GC	7		0	3	4	3	5	2	1	0	1	2	0	0	0	0
Ephemeroptera	Ephemeridae	Ephemera sp.	mayfly	CG	1		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemeroptera	Ephemeridae	Hexagenia sp.	mayfly	GC	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemeroptera	Serratellidae	Serratella sp.	mayfly	GC	0.6		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemeroptera	Heptageniidae	Maccaffertium mediopunctatum	mayfly	SC	3		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemeroptera	Heptageniidae	Maccaffertium sp.	mayfly	SC	4	1	0	3	2	3	0	3	1	4	1	1	2	17	22	13
Ephemeroptera	Heptageniidae	Stenacron interpunctatum	mayfly	OM	7		0	0	1	0	0	0	0	0	0	0	16	15	3	3
Ephemeroptera	Heptageniidae	Stenonema femoratum	mayfly	OM	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ephemeroptera	Isonychiidae	Isonychia sp.	mayfly	FC	2		1	0	0	0	1	0	0	0	0	0	0	0	0	0
Ephemeroptera	Leptophlebiidae	Leptophlebia sp.	mayfly	GC	4		0	0	0	4	1	0	0	0	1	0	3	0	3	1
Ephemeroptera	Potamanthidae	Anthopotamus verticis gr.	mayfly	GC	3.2		0	0	0	1	0	0	0	0	0	0	0	0	0	0
Ephemeroptera	Tricorythidae	Tricorythodes sp.	mayfly	GC	4		1	0	0	4	2	5	4	1	1	0	0	0	0	0
Odonata	Aeshnidae	Boyeria vinosa	dragonfly	PR	3.5		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Odonata	Calopterygidae	Haeterina sp.	damselfly	PR	6	2	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Odonata	Coenagrionidae	Argia sp.	damselfly	PR	5.1		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Odonata	Coenagrionidae	Enallagma sp.	damselfly	PR	9	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Odonata	Corduliidae	Neurocordulia sp.	dragonfly	PR	3		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Odonata	Gomphidae	spp 4	dragonfly	PR	4		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Odonata	Gomphidae	Gomphus sp.	dragonfly	PR	5		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plecoptera	Capniidae	Allocapnia sp.	stonefly	SH	3		0	0	0	0	0	0	0	2	0	1	0	0	0	0
Plecoptera	Chloroperlidae	Haploperla brevis	stonefly	PR	1		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plecoptera	Perlidae	Acroneuria sp.	stonefly	PR	1		0	0	0	0	0	0	0	0	0	0	0	0	1	0
Plecoptera	Taeniopterygidae	Taeniopteryx sp.	stonefly	SH	2		62	26	72	30	46	30	103	97	88	37	20	28	133	27
Megaloptera	Sialidae	Sialis sp.	alderfly	PR	4		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hemiptera	Belostomatidae	Belostoma lutarium	giant water bug	PR	9		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hemiptera	Corixidae	Sigara lineata	water boatmen	GC	8		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trichoptera	Brachycentridae	Brachycentrus sp.	caddisfly	FC	1	1	0	1	0	0	1	11	2	1	2	1	0	0	0	0
Trichoptera	Glossosomatidae	Protoptila sp.	caddisfly	SC	1		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trichoptera	Helicopsychidae	Helicopsyche borealis	caddisfly	SC	3		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trichoptera	Hydropsychidae	Cheumatopsyche sp.	caddisfly	FC	5	18	50	2	10	3	16	72	61	20	14	7	4	7	19	4
Trichoptera	Hydropsychidae	Hydropsyche aerata	caddisfly	FC	2.6		0	0	0	0	0	0	0	0	0	0	0	0	2	3

Appendix D. Benthic Invertebrate Community Data
Hester Dandy: Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	TR-REF-01-HD5	TR-REF-02-HD1	TR-REF-02-HD2	TR-REF-02-HD3	TR-REF-02-HD4	TR-REF-02-HD5
Nematoda		spp 1	round worm	PA	9	0	0	0	0	0	0
Tricladida	Planariidae	Dugesia tigrina	flat worm	PR	6	1	6	0	0	0	2
Hoplonemertea	Tetrastemmatidae	Prostoma graecense	proboscis worm	PR	8	0	0	0	0	0	0
Hirudinea	Erpobdellidae	Mooreobdella microstoma	leech	PR	8						
Hirudinea	Glossiphoniidae	Helobdella elongata	leech	PR	8	0	0	0	0	0	0
Hirudinea	Glossiphoniidae	Helobdella fusca	leech	PA	8	0	0	0	0	0	0
Hirudinea	Glossiphoniidae	Helobdella stagnalis	leech	PR	8	0	1	0	0	0	0
Tubificida	Naididae	Dero obtusa	naiad worm	GC	10	0	0	0	0	0	0
Tubificida	Naididae	Nais bretscheri	naiad worm	GC	6	0	0	0	0	0	0
Tubificida	Naididae	Nais sp.	naiad worm	GC	8	1	0	0	0	0	2
Tubificida	Naididae	Pristina longisoma	naiad worm	GC	9.9	0	0	0	0	0	0
Tubificida	Naididae	Slavina appendiculata	naiad worm	GC	6	0	0	0	0	0	0
Tubificida	Naididae	Stylaria lacustris	naiad worm	GC	6	0	0	0	0	0	0
Tubificida	Enchytraeidae	spp 2	aquatic worm	GC	10	0	0	0	0	0	0
Tubificida	Tubificidae	Branchiura sowerbyi	tube worm	GC	6	0	0	0	0	0	0
Tubificida	Tubificidae	Limnodrilus hoffmeisteri	tube worm	GC	10	0	0	0	0	0	0
Tubificida	Tubificidae	Limnodrilus sp.	tube worm	GC	10	0	0	0	0	0	0
Hydroida	Hydridae	Hydra sp.	polyp	PR	5	7	3	0	0	0	8
Basommatophora	Ancylidae	Ferrissia rivularis	limpet snail	SC	7	0	2	2	1	0	0
Basommatophora	Lymnaeidae	Fossaria sp.	pond snail	SC	2.6	0	0	0	0	0	0
Basommatophora	Physidae	Physa sp.	pouch snail	SC	9	0	2	1	0	1	0
Basommatophora	Planorbidae	Gyraulus parvus	ram's horn snail	SC	5.5	0	0	0	0	0	0
Basommatophora	Planorbidae	Helisoma sp.	ram's horn snail	SC	7	0	0	0	0	0	0
Basommatophora	Hydrobiidae	Amnicola sp.	dusky snail	SC	4	0	0	0	0	0	0
Mesogastropoda	Pleuroceridae	Goniobasis livescens	horn snail	SC	6	1	0	0	1	0	0
Mesogastropoda	Pleuroceridae	Leptoxis carinata	horn snail	SC	6	0	0	0	0	0	0
Veneroida	Dreissenidae	Dreissena polymorpha	zebra mussel	FC	8	0	0	4	1	2	1
Veneroida	Sphaeriidae	Pisidium sp.	pill clam	FC	4.6	0	0	0	0	0	1
Hydracarina		spp 3	water mite	PR	6	0	0	0	0	0	0
Amphipoda	Crangonyctidae	Crangonyx sp.	sideswimmer	GC	4	0	0	0	0	0	0
Amphipoda	Gammaridae	Gammarus fasciatus	sideswimmer	GC	3	21	69	85	51	38	12
Amphipoda	Hyalellidae	Hyalella azteca	sideswimmer	GC	8	0	0	0	0	0	0
Decapoda	Cambaridae	Orconectes sp.	crayfish	GC	5	0	1	0	0	1	0
Isopoda	Asellidae	Caecidotea sp.	sowbug	GC	6	0	0	0	0	0	0
Ephemeroptera	Baetidae	Acerpenna sp.	mayfly	SH	4	0	0	0	0	0	0
Ephemeroptera	Baetidae	Baetis sp.	mayfly	GC	3.1	0	0	0	0	0	0
Ephemeroptera	Baetidae	Centroptilum sp.	mayfly	GC	2	0	0	0	0	0	0
Ephemeroptera	Baetidae	Plauditus sp.	mayfly	GC	4	0	0	0	0	0	0
Ephemeroptera	Baetiscidae	Baetisca sp.	mayfly	GC	4	0	0	0	0	0	0
Ephemeroptera	Caenidae	Caenis sp.	mayfly	GC	7	0	0	1	0	4	0
Ephemeroptera	Ephemeridae	Ephemera sp.	mayfly	CG	1	0	0	0	0	0	0
Ephemeroptera	Ephemeridae	Hexagenia sp.	mayfly	GC	6	0	0	0	0	0	0
Ephemeroptera	Ephemerellidae	Serratella sp.	mayfly	GC	0.6	0	0	0	0	0	0
Ephemeroptera	Heptageniidae	Maccaffertium mediopunctatum	mayfly	SC	3	0	0	0	0	0	0
Ephemeroptera	Heptageniidae	Maccaffertium sp.	mayfly	SC	4	21	77	114	158	104	18
Ephemeroptera	Heptageniidae	Stenacron interpunctatum	mayfly	OM	7	13	8	24	4	12	4
Ephemeroptera	Heptageniidae	Stenonema femoratum	mayfly	OM	5	0	0	0	0	0	0
Ephemeroptera	Isonychiidae	Isonychia sp.	mayfly	FC	2	0	0	0	0	0	0
Ephemeroptera	Leptophlebiidae	Leptophlebia sp.	mayfly	GC	4	2	1	4	0	0	0
Ephemeroptera	Potamanthidae	Anthopotamus verticis gr.	mayfly	GC	3.2	0	1	0	0	0	0
Ephemeroptera	Tricorythidae	Tricorythodes sp.	mayfly	GC	4	0	0	1	0	0	0
Odonata	Aeshnidae	Boyeria vinosa	dragonfly	PR	3.5	0	0	0	0	0	0
Odonata	Calopterygidae	Haeterina sp.	damselfly	PR	6	0	0	0	0	0	0
Odonata	Coenagrionidae	Argia sp.	damselfly	PR	5.1	0	0	0	1	0	0
Odonata	Coenagrionidae	Enallagma sp.	damselfly	PR	9	0	0	2	0	0	0
Odonata	Corduliidae	Neurocordulia sp.	dragonfly	PR	3	0	0	0	0	0	0
Odonata	Gomphidae	spp 4	dragonfly	PR	4	0	0	0	0	0	0
Odonata	Gomphidae	Gomphus sp.	dragonfly	PR	5	0	0	0	0	0	0
Plecoptera	Capniidae	Allocapnia sp.	stonefly	SH	3	0	0	0	0	0	0
Plecoptera	Chloroperlidae	Haploperla brevis	stonefly	PR	1	0	0	0	0	0	0
Plecoptera	Perlidae	Acroneuria sp.	stonefly	PR	1	0	1	2	0	0	0
Plecoptera	Taeniopterygidae	Taeniopteryx sp.	stonefly	SH	2	24	33	55	56	24	3
Megaloptera	Sialidae	Sialis sp.	alderfly	PR	4	0	0	0	0	0	0
Hemiptera	Belostomatidae	Belostoma lutarium	giant water bug	PR	9	0	0	0	0	0	0
Hemiptera	Corixidae	Sigara lineata	water boatmen	GC	8	0	0	0	0	0	0
Trichoptera	Brachycentridae	Brachycentrus sp.	caddisfly	FC	1	1	1	0	0	1	0
Trichoptera	Glossosomatidae	Protoptila sp.	caddisfly	SC	1	0	0	0	1	0	0
Trichoptera	Helicopsychidae	Helicopsyche borealis	caddisfly	SC	3	0	0	0	0	0	0
Trichoptera	Hydropsychidae	Cheumatopsyche sp.	caddisfly	FC	5	11	19	64	33	23	9
Trichoptera	Hydropsychidae	Hydropsyche aerata	caddisfly	FC	2.6	0	1	3	1	1	1

Appendix D. Benthic Invertebrate Community Data
Hester Dandy: Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	CR-REF-01-HD1	CR-REF-01-HD2	CR-REF-01-HD3	CR-REF-01-HD4	CR-REF-01-HD5	CR-REF-02-HD1	CR-REF-02-HD2	CR-REF-02-HD3	CR-REF-02-HD4	CR-REF-02-HD5	RA-003-50-HD1	RA-003-50-HD2	RA-003-50-HD3	RA-003-50-HD4	RA-003-50-HD5
Trichoptera	Hydropsychidae	Hydropsyche bronta	caddisfly	FC	5															
Trichoptera	Hydropsychidae	Hydropsyche morosa	caddisfly	FC	2															
Trichoptera	Hydropsychidae	Hydropsyche phalerata	caddisfly	FC	1	16	25		2	4	1	1	3					1		
Trichoptera	Hydropsychidae	Hydropsyche sparna	caddisfly	FC	1															
Trichoptera	Hydropsychidae	Hydropsyche sp.	caddisfly	FC	5		1		1				1	1						
Trichoptera	Hydroptilidae	Hydroptilia sp.	caddisfly	PR	6															
Trichoptera	Hydroptilidae	Ithytrichia clavata	caddisfly	SC	1	1	1							2						
Trichoptera	Lepidostomatidae	Lepidostoma sp.	caddisfly	SH	1															
Trichoptera	Leptoceridae	Nectopsyche sp.	caddisfly	SH	2.4				1							1		2		
Trichoptera	Leptoceridae	Oecetis sp.	caddisfly	PR	8		1						3	2	1			1		
Trichoptera	Leptoceridae	Trienodes sp.	caddisfly	SH	3															
Trichoptera	Limnephilidae	Pycnopsyche sp.	caddisfly	SH	3.3						1									
Trichoptera	Polycentropodidae	Cymnellus fraternus	caddisfly	FC	8			1								1				
Trichoptera	Polycentropodidae	Neureclipsis sp.	caddisfly	FC	7	3	2				1		1		1					
Trichoptera	Polycentropodidae	Polycentropus sp.	caddisfly	PR	6								6	2	1	4	5	4	1	6
Trichoptera	Uenoidae	Neophylax sp.	caddisfly	SC	3															
Lepidoptera	Pyrilidae	Parapoynx sp.	moth	SH	5		3		3			1	4	1	3					1
Lepidoptera	Pyrilidae	Petrophila sp.	moth	SC	2.7															
Coleoptera	Elmidae	Ancyronyx variegatus	rifle beetle	OM	4															
Coleoptera	Elmidae	Dubiraphia vittata	rifle beetle	OM	7		1	1				1		2	1		1			2
Coleoptera	Elmidae	Macronychus glabratus	rifle beetle	OM	4		1		1						2	1		1		
Coleoptera	Elmidae	Optioservus sp.	rifle beetle	SC	4			2												
Coleoptera	Elmidae	Stenelmis crenata gr.	rifle beetle	SC	5	1														
Coleoptera	Gyrinidae	Dineutus sp.	whirligig beetle	PR	3.7															
Coleoptera	Hydrophilidae	Berosus sp.	scavenger beetle	PR	6.7															
Coleoptera	Psephenidae	Ectopria nervosus	false water penny	SC	5															
Coleoptera	Psephenidae	Psephenus herricki	water penny	SC	4															
Diptera	Athericidae	Atherix sp.	watersnipe fly	PR	4															
Diptera	Ceratopogonidae	Bezzia sp.	biting midge	GC	6							1			1	3			1	
Diptera	Ceratopogonidae	Ceratopogon sp.	biting midge	PR	6										1					
Diptera	Ceratopogonidae	Dasyhelea sp.	biting midge	GC	6															
Diptera	Ceratopogonidae	Palpomyia gr.	biting midge	PR	6															
Diptera	Ceratopogonidae	Probezzia sp.	biting midge	PR	6															
Diptera	Chironomidae	Ablabesmyia janta	midge	OM	4.9															
Diptera	Chironomidae	Ablabesmyia mallochi	midge	OM	8															
Diptera	Chironomidae	Chironomini	midge	GC	6															
Diptera	Chironomidae	Chironomus sp.	midge	GC	10	8	1	72	8	12	8	2	8	20	16	8	60	12	4	24
Diptera	Chironomidae	Cladotanytarsus sp.	midge	GC	7															
Diptera	Chironomidae	Corynoneura sp.	midge	GC	7	4		8		8	8	14				8	16	12	8	28
Diptera	Chironomidae	Cricotopus bicintus	midge	OM	6.7	12	8									8		4		
Diptera	Chironomidae	Cricotopus sp.	midge	SH	7															
Diptera	Chironomidae	Cricotopus trifasciata	midge	OM	7															
Diptera	Chironomidae	Cryptochironomus fulvus gr.	midge	PR	8									8	4	4	8	4	4	
Diptera	Chironomidae	Cryptotendipes sp.	midge	GC	6															
Diptera	Chironomidae	Dicrotendipes neomodestus	midge	FG	4.5							2					4	4	48	48
Diptera	Chironomidae	Endochironomus nigricans	midge	SH	8									8			36	24		
Diptera	Chironomidae	Eukiefferiella gracei gr.	midge	GC	4															
Diptera	Chironomidae	Eukiefferiella sp.	midge	GC	4		1							8						
Diptera	Chironomidae	Glyptotendipes sp.	midge	FC	10															
Diptera	Chironomidae	Labrundinia pilosella	midge	PR	3.1					4			8	36		24	4	4	12	52
Diptera	Chironomidae	Larsia sp.	midge	PR	4.3	8	2		4	8	10	4	8		12	8		4	16	28
Diptera	Chironomidae	Micropsectra sp.	midge	GC	3.5															
Diptera	Chironomidae	Microtendipes pedellus gr.	midge	FG	6										4					
Diptera	Chironomidae	Nanocladius sp.	midge	GC	3			4	4	8		2						32	20	24
Diptera	Chironomidae	Nilotanypus fimbriatus	midge	PR	2.8															
Diptera	Chironomidae	Orthoclaadiinae	midge	GC	6															
Diptera	Chironomidae	Orthoclaadius cplx.	midge	GC	6	4				4	4		8		4	8		24		
Diptera	Chironomidae	Orthoclaadius sp.	midge	GC	6							2					4			
Diptera	Chironomidae	Parachironomus sp.	midge	PR	4.1															
Diptera	Chironomidae	Parakiefferiella sp.	midge	GC	4.8													24	8	4
Diptera	Chironomidae	Paratanytarsus sp.	midge	GC	6	80			20	44	6		36					32		12
Diptera	Chironomidae	Paraphaenocladius sp.	midge	GC	4											4				
Diptera	Chironomidae	Paratendipes basidens	midge	GC	8							12								
Diptera	Chironomidae	Pentaneura inconspicua	midge	PR	4.9															
Diptera	Chironomidae	Polypedilum flavum	midge	SH	6	20	6	36	20	8	20	42	56	96	48		24	36	68	112
Diptera	Chironomidae	Polypedilum sp.	midge	SH	6							2				36	12		32	
Diptera	Chironomidae	Polypedilum tritum	midge	SH	6															
Diptera	Chironomidae	Potthastia longimanna	midge	GC	2															
Diptera	Chironomidae	Procladius sp.	midge	PR	9					4		6			4	8			12	
Diptera	Chironomidae	Pseudochironomus sp.	midge	GC	5															

Appendix D. Benthic Invertebrate Community Data
Hester Dandy: Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	RB-012-50-HD1	RB-012-50-HD2	RB-012-50-HD3	RB-012-50-HD4	RB-012-50-HD5	RE-061-00-HD1	RE-061-00-HD2	RE-061-00-HD3	RE-061-00-HD4	RE-061-00-HD5	RE-062-00-HD1	RE-062-00-HD2	RE-062-00-HD3	RE-062-00-HD4	RE-062-00-HD5
Trichoptera	Hydropsychidae	Hydropsyche bronta	caddisfly	FC	5						1									
Trichoptera	Hydropsychidae	Hydropsyche morosa	caddisfly	FC	2												5			
Trichoptera	Hydropsychidae	Hydropsyche phalerata	caddisfly	FC	1						7	4	1	1	2	4		4	5	3
Trichoptera	Hydropsychidae	Hydropsyche sparna	caddisfly	FC	1															
Trichoptera	Hydropsychidae	Hydropsyche sp.	caddisfly	FC	5	1					8	4		1	1	5	5	1	2	7
Trichoptera	Hydroptilidae	Hydroptilia sp.	caddisfly	PR	6			1		1							4			1
Trichoptera	Hydroptilidae	Ithytrichia clavata	caddisfly	SC	1											2		2		1
Trichoptera	Lepidostomatidae	Lepidostoma sp.	caddisfly	SH	1															
Trichoptera	Leptoceridae	Nectopsyche sp.	caddisfly	SH	2.4			2		1	1	1							1	
Trichoptera	Leptoceridae	Oecetis sp.	caddisfly	PR	8				2											
Trichoptera	Leptoceridae	Trienodes sp.	caddisfly	SH	3															
Trichoptera	Limnephilidae	Pycnopsyche sp.	caddisfly	SH	3.3											1	1			
Trichoptera	Polycentropodidae	Cymellus fraternus	caddisfly	FC	8	2		1												
Trichoptera	Polycentropodidae	Neureclipsis sp.	caddisfly	FC	7												1			
Trichoptera	Polycentropodidae	Polycentropus sp.	caddisfly	PR	6	1					1			1				1		
Trichoptera	Uenoidae	Neophylax sp.	caddisfly	SC	3															
Lepidoptera	Pyrilidae	Parapoynx sp.	moth	SH	5							1		2	1	2	3	4	2	2
Lepidoptera	Pyrilidae	Petrophila sp.	moth	SC	2.7															
Coleoptera	Elmidae	Ancronyx variegatus	rifle beetle	OM	4															
Coleoptera	Elmidae	Dubiraphia vittata	rifle beetle	OM	7								2			5	12	2	1	9
Coleoptera	Elmidae	Macronychus glabratus	rifle beetle	OM	4	1			1		2	1				3	1	1	1	1
Coleoptera	Elmidae	Optioservus sp.	rifle beetle	SC	4											2				
Coleoptera	Elmidae	Stenelmis crenata gr.	rifle beetle	SC	5								2	1	1	1		1		
Coleoptera	Gyrinidae	Dineutus sp.	whirligig beetle	PR	3.7															
Coleoptera	Hydrophilidae	Berosus sp.	scavenger beetle	PR	6.7											1				
Coleoptera	Psephenidae	Ectopria nervosus	false water penny	SC	5															
Coleoptera	Psephenidae	Psephenus herricki	water penny	SC	4															
Diptera	Athericidae	Atherix sp.	watersnipe fly	PR	4															
Diptera	Ceratopogonidae	Bezzia sp.	biting midge	GC	6															
Diptera	Ceratopogonidae	Ceratopogon sp.	biting midge	PR	6															
Diptera	Ceratopogonidae	Dasyhelea sp.	biting midge	GC	6															
Diptera	Ceratopogonidae	Palpomyia gr.	biting midge	PR	6															
Diptera	Ceratopogonidae	Probezzia sp.	biting midge	PR	6															
Diptera	Chironomidae	Ablabesmyia janta	midge	OM	4.9															
Diptera	Chironomidae	Ablabesmyia mallochi	midge	OM	8			4												
Diptera	Chironomidae	Chironomini	midge	GC	6															
Diptera	Chironomidae	Chironomus sp.	midge	GC	10	12	12	4			8	8	5	28	4			4		4
Diptera	Chironomidae	Cladotanytarsus sp.	midge	GC	7															
Diptera	Chironomidae	Corynoneura sp.	midge	GC	7	4	4		12			4					4		8	8
Diptera	Chironomidae	Cricotopus bicintus	midge	OM	6.7		4									1			16	
Diptera	Chironomidae	Cricotopus sp.	midge	SH	7															
Diptera	Chironomidae	Cricotopus trifasciata	midge	OM	7															
Diptera	Chironomidae	Cryptochironomus fulvus gr.	midge	PR	8		12	4												12
Diptera	Chironomidae	Cryptotendipes sp.	midge	GC	6															
Diptera	Chironomidae	Dicrotendipes neomodestus	midge	FG	4.5	36	8	88	28	40	4	8		4	4			4	12	
Diptera	Chironomidae	Endochironomus nigricans	midge	SH	8	20	4				4	4	1	4	4		8			
Diptera	Chironomidae	Eukiefferiella gracei gr.	midge	GC	4															
Diptera	Chironomidae	Eukiefferiella sp.	midge	GC	4						44									
Diptera	Chironomidae	Glyptotendipes sp.	midge	FC	10															
Diptera	Chironomidae	Labrundinia pilosella	midge	PR	3.1	28		12	12	8				4	8	8		4		
Diptera	Chironomidae	Larsia sp.	midge	PR	4.3		8	16			4	8	1	8	12	12	28	24	12	20
Diptera	Chironomidae	Micropsectra sp.	midge	GC	3.5															
Diptera	Chironomidae	Microtendipes pedellus gr.	midge	FG	6															
Diptera	Chironomidae	Nanocladius sp.	midge	GC	3	24						4	5	8	8				4	16
Diptera	Chironomidae	Nilotanypus fimbriatus	midge	PR	2.8															
Diptera	Chironomidae	Orthoclaadiinae	midge	GC	6															
Diptera	Chironomidae	Orthoclaadius cplx.	midge	GC	6					4	4	8	1			4	8	12	8	
Diptera	Chironomidae	Orthoclaadius sp.	midge	GC	6															
Diptera	Chironomidae	Parachironomus sp.	midge	PR	4.1															
Diptera	Chironomidae	Parakiefferiella sp.	midge	GC	4.8		12					12	8		4		4	16	4	
Diptera	Chironomidae	Paratanytarsus sp.	midge	GC	6				20		12	40		20	48			40	36	28
Diptera	Chironomidae	Paraphaenocladius sp.	midge	GC	4			4	28											
Diptera	Chironomidae	Paratendipes basidens	midge	GC	8															
Diptera	Chironomidae	Pentaneura inconspicua	midge	PR	4.9															
Diptera	Chironomidae	Polypedilum flavum	midge	SH	6	76		8	96	12	168	96	10	72	92	124	128	96	120	48
Diptera	Chironomidae	Polypedilum sp.	midge	SH	6		20	60	28	4										
Diptera	Chironomidae	Polypedilum tritum	midge	SH	6															
Diptera	Chironomidae	Potthastia longimanna	midge	GC	2															
Diptera	Chironomidae	Procladius sp.	midge	PR	9	4	4													
Diptera	Chironomidae	Pseudochironomus sp.	midge	GC	5															

Appendix D. Benthic Invertebrate Community Data
Hester Dandy: Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	RE-073-00-HD1	RE-073-00-HD2	RE-073-00-HD5	RF-082-00-HD1	RF-082-00-HD2	RF-082-00-HD3	RF-082-00-HD4	RF-082-00-HD5	RG-136-00-HD1	RG-136-00-HD2	RG-136-00-HD3	RG-136-00-HD4	RG-136-00-HD5	RG-137-50-HD1	RG-137-50-HD2
Trichoptera	Hydropsychidae	Hydropsyche bronta	caddisfly	FC	5															
Trichoptera	Hydropsychidae	Hydropsyche morosa	caddisfly	FC	2															
Trichoptera	Hydropsychidae	Hydropsyche phalerata	caddisfly	FC	1							1	10	2	2	3	2			1
Trichoptera	Hydropsychidae	Hydropsyche sparna	caddisfly	FC	1															
Trichoptera	Hydropsychidae	Hydropsyche sp.	caddisfly	FC	5								7	4	1	6	1	3	1	4
Trichoptera	Hydroptilidae	Hydroptilia sp.	caddisfly	PR	6	1		1	1			1	1		1	1				
Trichoptera	Hydroptilidae	Ithytrichia clavata	caddisfly	SC	1													1		
Trichoptera	Lepidostomatidae	Lepidostoma sp.	caddisfly	SH	1															
Trichoptera	Leptoceridae	Nectopsyche sp.	caddisfly	SH	2.4	2	10	14	1				1							1
Trichoptera	Leptoceridae	Oecetis sp.	caddisfly	PR	8															
Trichoptera	Leptoceridae	Trienodes sp.	caddisfly	SH	3										1	1				
Trichoptera	Limnephilidae	Pycnopsyche sp.	caddisfly	SH	3.3															
Trichoptera	Polycentropodidae	Cymellus fraternus	caddisfly	FC	8															
Trichoptera	Polycentropodidae	Neureclipsis sp.	caddisfly	FC	7				1										3	
Trichoptera	Polycentropodidae	Polycentropus sp.	caddisfly	PR	6			1								1				
Trichoptera	Uenoidae	Neophylax sp.	caddisfly	SC	3															
Lepidoptera	Pyrilidae	Parapoynx sp.	moth	SH	5					3				1		1				
Lepidoptera	Pyrilidae	Petrophila sp.	moth	SC	2.7															
Coleoptera	Elmidae	Ancryonyx variegatus	riffle beetle	OM	4									1						
Coleoptera	Elmidae	Dubiraphia vittata	riffle beetle	OM	7										1			1	4	2
Coleoptera	Elmidae	Macronychus glabratus	riffle beetle	OM	4	2		6		1			3	2	2	2				3
Coleoptera	Elmidae	Optioservus sp.	riffle beetle	SC	4												1			
Coleoptera	Elmidae	Stenelmis crenata gr.	riffle beetle	SC	5									1						
Coleoptera	Gyrinidae	Dineutus sp.	whirligig beetle	PR	3.7															
Coleoptera	Hydrophilidae	Berosus sp.	scavenger beetle	PR	6.7															
Coleoptera	Psephenidae	Ectopria nervosus	false water penny	SC	5															
Coleoptera	Psephenidae	Psephenus herricki	water penny	SC	4															
Diptera	Athericidae	Atherix sp.	watersnipe fly	PR	4															
Diptera	Ceratopogonidae	Bezzia sp.	biting midge	GC	6															
Diptera	Ceratopogonidae	Ceratopogon sp.	biting midge	PR	6															
Diptera	Ceratopogonidae	Dasyhelea sp.	biting midge	GC	6															
Diptera	Ceratopogonidae	Palpomyia gr.	biting midge	PR	6															
Diptera	Ceratopogonidae	Probezzia sp.	biting midge	PR	6															
Diptera	Chironomidae	Ablabesmyia janta	midge	OM	4.9															
Diptera	Chironomidae	Ablabesmyia mallochi	midge	OM	8															
Diptera	Chironomidae	Chironomini	midge	GC	6															
Diptera	Chironomidae	Chironomus sp.	midge	GC	10		24	12	3	11				8		4	20	8	8	
Diptera	Chironomidae	Cladotanytarsus sp.	midge	GC	7															
Diptera	Chironomidae	Corynoneura sp.	midge	GC	7	6	4			8	20	12				4		8		8
Diptera	Chironomidae	Cricotopus bicintus	midge	OM	6.7					1		8	8	20		12	48	8		40
Diptera	Chironomidae	Cricotopus sp.	midge	SH	7															
Diptera	Chironomidae	Cricotopus trifasciata	midge	OM	7															
Diptera	Chironomidae	Cryptochironomus fulvus gr.	midge	PR	8	4			1											
Diptera	Chironomidae	Cryptotendipes sp.	midge	GC	6															
Diptera	Chironomidae	Dicrotendipes neomodestus	midge	FG	4.5	41	116	16	5	1	48		12		12				4	8
Diptera	Chironomidae	Endochironomus nigricans	midge	SH	8				5											
Diptera	Chironomidae	Eukiefferiella gracei gr.	midge	GC	4															
Diptera	Chironomidae	Eukiefferiella sp.	midge	GC	4															
Diptera	Chironomidae	Glyptotendipes sp.	midge	FC	10															
Diptera	Chironomidae	Labrundinia pilosella	midge	PR	3.1	14	12	8		7	4	28								
Diptera	Chironomidae	Larsia sp.	midge	PR	4.3	3	4	12	2		8	12	8	4	12					
Diptera	Chironomidae	Micropsectra sp.	midge	GC	3.5															
Diptera	Chironomidae	Microtendipes pedellus gr.	midge	FG	6															
Diptera	Chironomidae	Nanocladius sp.	midge	GC	3	2		44	21	6			8		16	4			4	
Diptera	Chironomidae	Nilotanypus fimbriatus	midge	PR	2.8															
Diptera	Chironomidae	Orthocladiinae	midge	GC	6														4	
Diptera	Chironomidae	Orthocladius cplx.	midge	GC	6	1	12	16		1		4	8	88	28	32	20			72
Diptera	Chironomidae	Orthocladius sp.	midge	GC	6													56		
Diptera	Chironomidae	Parachironomus sp.	midge	PR	4.1	29	92					52								
Diptera	Chironomidae	Parakiefferiella sp.	midge	GC	4.8			32												
Diptera	Chironomidae	Paratanytarsus sp.	midge	GC	6	6	4							52				28		
Diptera	Chironomidae	Paraphaenocladius sp.	midge	GC	4															
Diptera	Chironomidae	Paratendipes basidens	midge	GC	8															
Diptera	Chironomidae	Pentaneura inconspicua	midge	PR	4.9											24	12		20	
Diptera	Chironomidae	Polypedilum flavum	midge	SH	6	7	32	104	10	35	48	52	92	44	32	36	24	20	32	80
Diptera	Chironomidae	Polypedilum sp.	midge	SH	6	14		12	3								8			8
Diptera	Chironomidae	Polypedilum tritum	midge	SH	6															
Diptera	Chironomidae	Potthastia longimana	midge	GC	2															
Diptera	Chironomidae	Procladius sp.	midge	PR	9	3		4	3											
Diptera	Chironomidae	Pseudochironomus sp.	midge	GC	5															

Appendix D. Benthic Invertebrate Community Data
Hester Dandy: Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	RG-137-50-HD3	RG-137-50-HD4	RG-137-50-HD5	RH-143-00-HD1	RH-143-00-HD2	RH-143-00-HD3	RH-144-50-HD1	RH-144-50-HD2	RH-144-50-HD3	RH-144-50-HD4	RH-144-50-HD5	RH-150-00-HD1	RH-150-00-HD2	RH-150-00-HD3	RH-150-00-HD4
Trichoptera	Hydropsychidae	Hydropsyche bronta	caddisfly	FC	5															
Trichoptera	Hydropsychidae	Hydropsyche morosa	caddisfly	FC	2		1				1									
Trichoptera	Hydropsychidae	Hydropsyche phalerata	caddisfly	FC	1		7	1	5	1	2		1							
Trichoptera	Hydropsychidae	Hydropsyche sparna	caddisfly	FC	1															
Trichoptera	Hydropsychidae	Hydropsyche sp.	caddisfly	FC	5	1	4	1		2	6		2	1						
Trichoptera	Hydroptilidae	Hydroptilia sp.	caddisfly	PR	6						1	1		2					1	
Trichoptera	Hydroptilidae	Ithytrichia clavata	caddisfly	SC	1				1											
Trichoptera	Lepidostomatidae	Lepidostoma sp.	caddisfly	SH	1															
Trichoptera	Leptoceridae	Nectopsyche sp.	caddisfly	SH	2.4			2		1	2			1						
Trichoptera	Leptoceridae	Oecetis sp.	caddisfly	PR	8															
Trichoptera	Leptoceridae	Trienodes sp.	caddisfly	SH	3															
Trichoptera	Limnephilidae	Pycnopsyche sp.	caddisfly	SH	3.3															
Trichoptera	Polycentropodidae	Cymnellus fraternus	caddisfly	FC	8				1	3	3				1				1	
Trichoptera	Polycentropodidae	Neureclipsis sp.	caddisfly	FC	7			1	1		2			2	1	3	1		1	1
Trichoptera	Polycentropodidae	Polycentropus sp.	caddisfly	PR	6			1		1										
Trichoptera	Uenoidae	Neophylax sp.	caddisfly	SC	3															
Lepidoptera	Pyrilidae	Parapoynx sp.	moth	SH	5		2									2				
Lepidoptera	Pyrilidae	Petrophila sp.	moth	SC	2.7															
Coleoptera	Elmidae	Ancyronyx variegatus	riffle beetle	OM	4															
Coleoptera	Elmidae	Dubiraphia vittata	riffle beetle	OM	7	3	1				1	1		1	2	2				
Coleoptera	Elmidae	Macronychus glabratus	riffle beetle	OM	4			1			2			1	1	4				
Coleoptera	Elmidae	Optioservus sp.	riffle beetle	SC	4															
Coleoptera	Elmidae	Stenelmis crenata gr.	riffle beetle	SC	5						1									
Coleoptera	Gyrinidae	Dineutus sp.	whirligig beetle	PR	3.7															
Coleoptera	Hydrophilidae	Berosus sp.	scavenger beetle	PR	6.7															
Coleoptera	Psephenidae	Ectopria nervosus	false water penny	SC	5															
Coleoptera	Psephenidae	Psephenus herricki	water penny	SC	4															
Diptera	Athericidae	Atherix sp.	watersnipe fly	PR	4															
Diptera	Ceratopogonidae	Bezzia sp.	biting midge	GC	6							1								
Diptera	Ceratopogonidae	Ceratopogon sp.	biting midge	PR	6															
Diptera	Ceratopogonidae	Dasyhelea sp.	biting midge	GC	6															
Diptera	Ceratopogonidae	Palpomyia gr.	biting midge	PR	6															
Diptera	Ceratopogonidae	Probezzia sp.	biting midge	PR	6															
Diptera	Chironomidae	Ablabesmyia janta	midge	OM	4.9															
Diptera	Chironomidae	Ablabesmyia mallochi	midge	OM	8															
Diptera	Chironomidae	Chironomini	midge	GC	6			8		4										
Diptera	Chironomidae	Chironomus sp.	midge	GC	10	8	16	24					8	16					12	
Diptera	Chironomidae	Cladotanytarsus sp.	midge	GC	7															
Diptera	Chironomidae	Corynoneura sp.	midge	GC	7	8						4		8			12	16	12	24
Diptera	Chironomidae	Cricotopus bicintus	midge	OM	6.7	16	40			4		4		96	48		24	4	8	
Diptera	Chironomidae	Cricotopus sp.	midge	SH	7															
Diptera	Chironomidae	Cricotopus trifasciata	midge	OM	7					4										
Diptera	Chironomidae	Cryptochironomus fulvus gr.	midge	PR	8									8	16				4	4
Diptera	Chironomidae	Cryptotendipes sp.	midge	GC	6															
Diptera	Chironomidae	Dicrotendipes neomodestus	midge	FG	4.5			24	8	8	72	4	16	40	8		12	32	4	4
Diptera	Chironomidae	Endochironomus nigricans	midge	SH	8													4		
Diptera	Chironomidae	Eukiefferiella gracei gr.	midge	GC	4															
Diptera	Chironomidae	Eukiefferiella sp.	midge	GC	4															
Diptera	Chironomidae	Glyptotendipes sp.	midge	FC	10															
Diptera	Chironomidae	Labrundinia pilosella	midge	PR	3.1						4								8	
Diptera	Chironomidae	Larsia sp.	midge	PR	4.3														12	
Diptera	Chironomidae	Micropsectra sp.	midge	GC	3.5															
Diptera	Chironomidae	Microtendipes pedellus gr.	midge	FG	6															
Diptera	Chironomidae	Nanocladius sp.	midge	GC	3						16									
Diptera	Chironomidae	Nilotanypus fimbriatus	midge	PR	2.8															
Diptera	Chironomidae	Orthoclaadiinae	midge	GC	6				12		4									
Diptera	Chironomidae	Orthoclaadius cplx.	midge	GC	6	48	32	40	40	4	32	20	40		16	64	24	24	24	48
Diptera	Chironomidae	Orthoclaadius sp.	midge	GC	6															
Diptera	Chironomidae	Parachironomus sp.	midge	PR	4.1													8		
Diptera	Chironomidae	Parakiefferiella sp.	midge	GC	4.8															
Diptera	Chironomidae	Paratanytarsus sp.	midge	GC	6						72				80	80			40	
Diptera	Chironomidae	Paraphaenoclaadius sp.	midge	GC	4															
Diptera	Chironomidae	Paratendipes basidens	midge	GC	8															
Diptera	Chironomidae	Pentaneura inconspicua	midge	PR	4.9	8	24		8		20	20		16						16
Diptera	Chironomidae	Polypedilum flavum	midge	SH	6	72	88	64	48	32	72	44	40	64	104	40	28		84	68
Diptera	Chironomidae	Polypedilum sp.	midge	SH	6	16						4					4	60	28	
Diptera	Chironomidae	Polypedilum tritum	midge	SH	6															
Diptera	Chironomidae	Potthastia longimanna	midge	GC	2															
Diptera	Chironomidae	Procladius sp.	midge	PR	9													20		
Diptera	Chironomidae	Pseudochironomus sp.	midge	GC	5															

Appendix D. Benthic Invertebrate Community Data
Hester Dandy: Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	RH-150-00-HD5	RI-164-00-HD1	RI-164-00-HD2	RI-164-00-HD3	RI-164-00-HD4	RI-164-00-HD5	RI-164-50-HD1	RI-164-50-HD2	RI-164-50-HD3	RI-164-50-HD4	RI-164-50-HD5	RI-168-50-HD1	RI-168-50-HD2	RI-168-50-HD3	RI-168-50-HD4
Trichoptera	Hydropsychidae	Hydropsyche bronta	caddisfly	FC	5															1
Trichoptera	Hydropsychidae	Hydropsyche morosa	caddisfly	FC	2															
Trichoptera	Hydropsychidae	Hydropsyche phalerata	caddisfly	FC	1		1	1	5		1							4	2	1
Trichoptera	Hydropsychidae	Hydropsyche sparna	caddisfly	FC	1															
Trichoptera	Hydropsychidae	Hydropsyche sp.	caddisfly	FC	5		1		6	3	2				1		4	10	3	20
Trichoptera	Hydroptilidae	Hydroptilia sp.	caddisfly	PR	6				1											1
Trichoptera	Hydroptilidae	Ithytrichia clavata	caddisfly	SC	1															
Trichoptera	Lepidostomatidae	Lepidostoma sp.	caddisfly	SH	1															
Trichoptera	Leptoceridae	Nectopsyche sp.	caddisfly	SH	2.4					1	1									
Trichoptera	Leptoceridae	Oecetis sp.	caddisfly	PR	8															
Trichoptera	Leptoceridae	Trienodes sp.	caddisfly	SH	3															
Trichoptera	Limnephilidae	Pycnopsyche sp.	caddisfly	SH	3.3															
Trichoptera	Polycentropodidae	Cymnellus fraternus	caddisfly	FC	8	4	1	3	1	1										
Trichoptera	Polycentropodidae	Neureclipsis sp.	caddisfly	FC	7	2	1	1	4											
Trichoptera	Polycentropodidae	Polycentropus sp.	caddisfly	PR	6					1	1									
Trichoptera	Uenoidae	Neophylax sp.	caddisfly	SC	3															
Lepidoptera	Pyrilidae	Parapoynx sp.	moth	SH	5						1									
Lepidoptera	Pyrilidae	Petrophila sp.	moth	SC	2.7															
Coleoptera	Elmidae	Ancyronyx variegatus	rifle beetle	OM	4									2						
Coleoptera	Elmidae	Dubiraphia vittata	rifle beetle	OM	7	1		1				1	1						7	2
Coleoptera	Elmidae	Macronychus glabratus	rifle beetle	OM	4					1		3	5	4	2			1	3	5
Coleoptera	Elmidae	Optioservus sp.	rifle beetle	SC	4															
Coleoptera	Elmidae	Stenelmis crenata gr.	rifle beetle	SC	5															
Coleoptera	Gyrinidae	Dineutus sp.	whirligig beetle	PR	3.7															
Coleoptera	Hydrophilidae	Berosus sp.	scavenger beetle	PR	6.7									1			1			
Coleoptera	Psephenidae	Ectopria nervosus	false water penny	SC	5															
Coleoptera	Psephenidae	Psephenus herricki	water penny	SC	4															
Diptera	Athericidae	Atherix sp.	watersnipe fly	PR	4															
Diptera	Ceratopogonidae	Bezzia sp.	biting midge	GC	6															
Diptera	Ceratopogonidae	Ceratopogon sp.	biting midge	PR	6															
Diptera	Ceratopogonidae	Dasyhelea sp.	biting midge	GC	6		4													
Diptera	Ceratopogonidae	Palpomyia gr.	biting midge	PR	6															
Diptera	Ceratopogonidae	Probezzia sp.	biting midge	PR	6															
Diptera	Chironomidae	Ablabesmyia janta	midge	OM	4.9															
Diptera	Chironomidae	Ablabesmyia mallochi	midge	OM	8															
Diptera	Chironomidae	Chironomini	midge	GC	6	4			16			84		28	24	24	4			
Diptera	Chironomidae	Chironomus sp.	midge	GC	10		8	20		4	1	4	8	8	24		16	24	12	16
Diptera	Chironomidae	Cladotanytarsus sp.	midge	GC	7															
Diptera	Chironomidae	Corynoneura sp.	midge	GC	7		8	20	8	1		4			8					
Diptera	Chironomidae	Cricotopus bicintus	midge	OM	6.7	4	32	8	32	2	2		8	32				88	48	40
Diptera	Chironomidae	Cricotopus sp.	midge	SH	7															
Diptera	Chironomidae	Cricotopus trifasciata	midge	OM	7														48	
Diptera	Chironomidae	Cryptochironomus fulvus gr.	midge	PR	8							4								
Diptera	Chironomidae	Cryptotendipes sp.	midge	GC	6															
Diptera	Chironomidae	Dicrotendipes neomodestus	midge	FG	4.5	28	8	8	24	11	25	32		28	64		16	8	4	16
Diptera	Chironomidae	Endochironomus nigricans	midge	SH	8					1	1						4			
Diptera	Chironomidae	Eukiefferiella gracei gr.	midge	GC	4															
Diptera	Chironomidae	Eukiefferiella sp.	midge	GC	4															
Diptera	Chironomidae	Glyptotendipes sp.	midge	FC	10															
Diptera	Chironomidae	Labrundinia pilosella	midge	PR	3.1	4			8		1	12			4					
Diptera	Chironomidae	Larsia sp.	midge	PR	4.3															
Diptera	Chironomidae	Micropsectra sp.	midge	GC	3.5												4			
Diptera	Chironomidae	Microtendipes pedellus gr.	midge	FG	6															
Diptera	Chironomidae	Nanocladius sp.	midge	GC	3			8	8				12	28						
Diptera	Chironomidae	Nilotanypus fimbriatus	midge	PR	2.8		12													
Diptera	Chironomidae	Orthoclaadiinae	midge	GC	6													24		
Diptera	Chironomidae	Orthoclaadius cplx.	midge	GC	6	8		16	96	2	6	28			36	12	140	24	100	40
Diptera	Chironomidae	Orthoclaadius sp.	midge	GC	6															
Diptera	Chironomidae	Parachironomus sp.	midge	PR	4.1								4	28						
Diptera	Chironomidae	Parakiefferiella sp.	midge	GC	4.8															
Diptera	Chironomidae	Paratanytarsus sp.	midge	GC	6	28	24			5				12						
Diptera	Chironomidae	Paraphaenocladius sp.	midge	GC	4												4			
Diptera	Chironomidae	Paratendipes basidens	midge	GC	8															
Diptera	Chironomidae	Pentaneura inconspicua	midge	PR	4.9	12	16	24	16		2		8	4	48	4				8
Diptera	Chironomidae	Polypedilum flavum	midge	SH	6	84	24	20	72	3	11		56	4	4		32	44	72	56
Diptera	Chironomidae	Polypedilum sp.	midge	SH	6						2	52		60	24	96				
Diptera	Chironomidae	Polypedilum tritum	midge	SH	6															
Diptera	Chironomidae	Potthastia longimanna	midge	GC	2															
Diptera	Chironomidae	Procladius sp.	midge	PR	9															
Diptera	Chironomidae	Pseudochironomus sp.	midge	GC	5															

Appendix D. Benthic Invertebrate Community Data
Hester Dandy: Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	RI-168-50-HD5	RK-201-00-HD1	RK-201-00-HD2	RK-201-00-HD3	RK-201-00-HD4	RK-201-00-HD5	RM-285-00-HD1	RM-285-00-HD2	RM-285-00-HD3	RM-285-00-HD4	RM-285-00-HD5	TR-REF-01-HD1	TR-REF-01-HD2	TR-REF-01-HD3	TR-REF-01-HD4
Trichoptera	Hydropsychidae	Hydropsyche bronta	caddisfly	FC	5		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trichoptera	Hydropsychidae	Hydropsyche morosa	caddisfly	FC	2		0	0	0	0	0	0	0	0	0	0	0	0	1	0
Trichoptera	Hydropsychidae	Hydropsyche phalerata	caddisfly	FC	1	1	6	0	0	0	0	0	0	7	3	0	0	2	7	0
Trichoptera	Hydropsychidae	Hydropsyche sparna	caddisfly	FC	1		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trichoptera	Hydropsychidae	Hydropsyche sp.	caddisfly	FC	5	7	15	0	3	1	5	39	68	15	9	11	4	5	13	4
Trichoptera	Hydroptilidae	Hydroptilia sp.	caddisfly	PR	6		1	1	0	1	0	1	0	0	0	0	0	0	0	0
Trichoptera	Hydroptilidae	Ithytrichia clavata	caddisfly	SC	1		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trichoptera	Lepidostomatidae	Lepidostoma sp.	caddisfly	SH	1		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trichoptera	Leptoceridae	Nectopsyche sp.	caddisfly	SH	2.4		0	0	0	0	0	0	2	0	0	0	1	1	0	0
Trichoptera	Leptoceridae	Oecetis sp.	caddisfly	PR	8		0	0	0	0	0	0	0	0	0	0	0	0	1	0
Trichoptera	Leptoceridae	Triaenodes sp.	caddisfly	SH	3		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trichoptera	Limnephilidae	Pycnopsyche sp.	caddisfly	SH	3.3		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trichoptera	Polycentropodidae	Cynellus fraternus	caddisfly	FC	8		0	0	0	0	0	0	0	0	1	0	0	0	0	0
Trichoptera	Polycentropodidae	Neureclipsis sp.	caddisfly	FC	7		0	0	0	0	0	0	0	0	0	0	0	2	0	0
Trichoptera	Polycentropodidae	Polycentropus sp.	caddisfly	PR	6		1	0	0	0	0	0	0	0	0	0	1	7	2	1
Trichoptera	Uenoidae	Neophylax sp.	caddisfly	SC	3		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidoptera	Pyrilidae	Parapoynx sp.	moth	SH	5		0	0	2	0	0	0	0	0	0	0	0	0	1	1
Lepidoptera	Pyrilidae	Petrophila sp.	moth	SC	2.7		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coleoptera	Elmidae	Ancyronyx variegatus	rifle beetle	OM	4		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coleoptera	Elmidae	Dubiraphia vittata	rifle beetle	OM	7	5	0	0	0	2	0	0	0	0	0	1	0	1	1	0
Coleoptera	Elmidae	Macronychus glabratus	rifle beetle	OM	4	3	0	3	0	0	1	1	1	1	0	0	1	0	0	0
Coleoptera	Elmidae	Optioservus sp.	rifle beetle	SC	4		0	0	0	1	0	0	0	0	0	0	0	0	0	0
Coleoptera	Elmidae	Stenelmis crenata gr.	rifle beetle	SC	5		1	0	0	0	0	0	0	0	0	0	0	0	0	0
Coleoptera	Gyrinidae	Dineutus sp.	whirligig beetle	PR	3.7		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coleoptera	Hydrophilidae	Berosus sp.	scavenger beetle	PR	6.7		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coleoptera	Psephenidae	Ectopria nervosus	false water penny	SC	5		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coleoptera	Psephenidae	Psephenus herricki	water penny	SC	4		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Athericidae	Atherix sp.	watersnipe fly	PR	4		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Ceratopogonidae	Bezzia sp.	biting midge	GC	6		0	0	0	0	0	0	0	1	0	0	0	0	0	0
Diptera	Ceratopogonidae	Ceratopogon sp.	biting midge	PR	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Ceratopogonidae	Dasyhelea sp.	biting midge	GC	6															
Diptera	Ceratopogonidae	Palpomyia gr.	biting midge	PR	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Ceratopogonidae	Probezzia sp.	biting midge	PR	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	Ablabesmyia janta	midge	OM	4.9		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	Ablabesmyia mallochi	midge	OM	8		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	Chironomini	midge	GC	6		0	0	0	0	0	0	0	0	4	0	0	0	0	0
Diptera	Chironomidae	Chironomus sp.	midge	GC	10	8	0	0	4	2	4	0	0	0	8	0	0	1	0	0
Diptera	Chironomidae	Cladotanytarsus sp.	midge	GC	7		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	Corynoneura sp.	midge	GC	7		0	0	12	0	0	0	0	0	0	8	1	1	0	0
Diptera	Chironomidae	Cricotopus bicintus	midge	OM	6.7	12	32	32	28	4	28	56	8	0	0	0	0	0	0	0
Diptera	Chironomidae	Cricotopus sp.	midge	SH	7		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	Cricotopus trifasciata	midge	OM	7		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	Cryptochironomus fulvus gr.	midge	PR	8		0	0	0	2	0	0	0	0	4	0	1	0	0	0
Diptera	Chironomidae	Cryptotendipes sp.	midge	GC	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	Dicrotendipes neomodestus	midge	FG	4.5	8	4	2	12	6	8	0	0	0	12	4	11	0	4	5
Diptera	Chironomidae	Endochironomus nigricans	midge	SH	8		0	0	0	0	0	0	0	0	0	4	0	0	0	0
Diptera	Chironomidae	Eukiefferiella gracei gr.	midge	GC	4		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	Eukiefferiella sp.	midge	GC	4		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	Glyptotendipes sp.	midge	FC	10		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	Labrundinia pilosella	midge	PR	3.1	4	0	0	0	0	0	0	0	0	0	4	0	0	0	0
Diptera	Chironomidae	Larsia sp.	midge	PR	4.3		0	4	8	0	2	0	4	0	0	4	9	4	0	2
Diptera	Chironomidae	Micropsectra sp.	midge	GC	3.5		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	Microtendipes pedellus gr.	midge	FG	6		0	0	0	0	0	0	0	0	0	0	4	4	3	4
Diptera	Chironomidae	Nanocladius sp.	midge	GC	3		0	0	0	0	0	0	8	0	0	4	1	0	0	0
Diptera	Chironomidae	Nilotanypus fimbriatus	midge	PR	2.8		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	Orthocladiinae	midge	GC	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	Orthocladius cplx.	midge	GC	6		64	0	28	12	0	0	12	12	20	8	2	1	1	1
Diptera	Chironomidae	Orthocladius sp.	midge	GC	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	Parachironomus sp.	midge	PR	4.1		0	0	0	0	0	0	0	0	0	0	1	0	0	1
Diptera	Chironomidae	Parakiefferiella sp.	midge	GC	4.8		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	Paratanytarsus sp.	midge	GC	6		0	0	0	8	0	0	0	0	0	24	3	0	0	2
Diptera	Chironomidae	Paraphaenocladius sp.	midge	GC	4		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	Paratendipes basidens	midge	GC	8		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	Pentaneura inconspicua	midge	PR	4.9		4	0	0	0	0	0	0	12	0	0	0	0	0	0
Diptera	Chironomidae	Polypedilum flavum	midge	SH	6	48	32	18	88	36	28	36	84	52	68	84	36	11	70	14
Diptera	Chironomidae	Polypedilum sp.	midge	SH	6		0	0	0	2	6	0	0	0	0	8	0	2	0	4
Diptera	Chironomidae	Polypedilum tritum	midge	SH	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	Potthastia longimanna	midge	GC	2		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	Procladius sp.	midge	PR	9		0	0	0	0	0	0	0	4	0	0	2	0	0	0
Diptera	Chironomidae	Pseudochironomus sp.	midge	GC	5		0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix D. Benthic Invertebrate Community Data
Hester Dandy: Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	TR-REF-01-HD5	TR-REF-02-HD1	TR-REF-02-HD2	TR-REF-02-HD3	TR-REF-02-HD4	TR-REF-02-HD5
Trichoptera	Hydropsychidae	Hydropsyche bronta	caddisfly	FC	5	0	0	0	0	0	0
Trichoptera	Hydropsychidae	Hydropsyche morosa	caddisfly	FC	2	0	0	0	0	0	0
Trichoptera	Hydropsychidae	Hydropsyche phalerata	caddisfly	FC	1	0	0	4	2	4	0
Trichoptera	Hydropsychidae	Hydropsyche sparna	caddisfly	FC	1	0	0	0	0	0	0
Trichoptera	Hydropsychidae	Hydropsyche sp.	caddisfly	FC	5	9	5	26	42	21	3
Trichoptera	Hydroptilidae	Hydroptilia sp.	caddisfly	PR	6	0	0	0	0	0	0
Trichoptera	Hydroptilidae	Ithytrichia clavata	caddisfly	SC	1	0	0	0	0	0	0
Trichoptera	Lepidostomatidae	Lepidostoma sp.	caddisfly	SH	1	0	0	0	0	0	0
Trichoptera	Leptoceridae	Nectopsyche sp.	caddisfly	SH	2.4	0	1	0	1	0	1
Trichoptera	Leptoceridae	Oecetis sp.	caddisfly	PR	8	0	0	0	0	0	0
Trichoptera	Leptoceridae	Trienodes sp.	caddisfly	SH	3	0	0	1	0	0	0
Trichoptera	Limnephilidae	Pycnopsyche sp.	caddisfly	SH	3.3	0	0	0	0	0	0
Trichoptera	Polycentropodidae	Cymellus fraternus	caddisfly	FC	8	0	0	0	0	0	0
Trichoptera	Polycentropodidae	Neureclipsis sp.	caddisfly	FC	7	0	0	0	0	0	0
Trichoptera	Polycentropodidae	Polycentropus sp.	caddisfly	PR	6	4	0	3	0	1	0
Trichoptera	Uenoidae	Neophylax sp.	caddisfly	SC	3	0	0	0	0	0	0
Lepidoptera	Pyrilidae	Parapoynx sp.	moth	SH	5	1	1	4	1	0	0
Lepidoptera	Pyrilidae	Petrophila sp.	moth	SC	2.7	0	0	1	0	0	0
Coleoptera	Elmidae	Ancyronyx variegatus	riffle beetle	OM	4	0	0	0	0	0	0
Coleoptera	Elmidae	Dubiraphia vittata	riffle beetle	OM	7	0	1	6	2	1	0
Coleoptera	Elmidae	Macronychus glabratus	riffle beetle	OM	4	1	0	0	1	0	0
Coleoptera	Elmidae	Optioservus sp.	riffle beetle	SC	4	0	0	0	0	0	0
Coleoptera	Elmidae	Stenelmis crenata gr.	riffle beetle	SC	5	0	0	0	0	1	0
Coleoptera	Gyrinidae	Dineutus sp.	whirligig beetle	PR	3.7	0	0	0	0	0	0
Coleoptera	Hydrophilidae	Berosus sp.	scavenger beetle	PR	6.7	0	0	0	0	0	0
Coleoptera	Psephenidae	Ectopria nervosus	false water penny	SC	5	0	0	0	0	0	0
Coleoptera	Psephenidae	Psephenus herricki	water penny	SC	4	0	0	0	0	0	0
Diptera	Athericidae	Atherix sp.	watersnipe fly	PR	4	0	0	0	0	0	0
Diptera	Ceratopogonidae	Bezzia sp.	biting midge	GC	6	0	0	0	0	0	0
Diptera	Ceratopogonidae	Ceratopogon sp.	biting midge	PR	6	0	0	0	0	0	0
Diptera	Ceratopogonidae	Dasyhelea sp.	biting midge	GC	6						
Diptera	Ceratopogonidae	Palpomyia gr.	biting midge	PR	6	0	0	0	0	0	0
Diptera	Ceratopogonidae	Probezzia sp.	biting midge	PR	6	0	0	0	0	0	0
Diptera	Chironomidae	Ablabesmyia janta	midge	OM	4.9	0	0	0	0	0	0
Diptera	Chironomidae	Ablabesmyia mallochi	midge	OM	8	0	0	0	0	0	0
Diptera	Chironomidae	Chironomini	midge	GC	6	0	0	0	0	0	0
Diptera	Chironomidae	Chironomus sp.	midge	GC	10	0	1	1	0	0	0
Diptera	Chironomidae	Cladotanytarsus sp.	midge	GC	7	0	0	0	0	2	0
Diptera	Chironomidae	Corynoneura sp.	midge	GC	7	2	0	0	0	0	0
Diptera	Chironomidae	Cricotopus bicintus	midge	OM	6.7	4	0	0	0	0	0
Diptera	Chironomidae	Cricotopus sp.	midge	SH	7	0	0	0	0	0	0
Diptera	Chironomidae	Cricotopus trifasciata	midge	OM	7	0	0	0	0	0	0
Diptera	Chironomidae	Cryptochironomus fulvus gr.	midge	PR	8	0	0	1	0	0	0
Diptera	Chironomidae	Cryptotendipes sp.	midge	GC	6	0	0	0	0	0	0
Diptera	Chironomidae	Dicrotendipes neomodestus	midge	FG	4.5	1	1	1	2	1	0
Diptera	Chironomidae	Endochironomus nigricans	midge	SH	8	0	0	1	0	0	0
Diptera	Chironomidae	Eukiefferiella gracei gr.	midge	GC	4	0	0	0	0	0	0
Diptera	Chironomidae	Eukiefferiella sp.	midge	GC	4	0	0	0	0	0	0
Diptera	Chironomidae	Glyptotendipes sp.	midge	FC	10	0	0	0	0	0	0
Diptera	Chironomidae	Labrundinia pilosella	midge	PR	3.1	0	0	0	0	0	0
Diptera	Chironomidae	Larsia sp.	midge	PR	4.3	1	4	0	0	4	1
Diptera	Chironomidae	Micropsectra sp.	midge	GC	3.5	0	0	0	0	0	0
Diptera	Chironomidae	Microtendipes pedellus gr.	midge	FG	6	0	0	1	0	0	0
Diptera	Chironomidae	Nanocladius sp.	midge	GC	3	0	0	0	1	0	0
Diptera	Chironomidae	Nilotanypus fimbriatus	midge	PR	2.8	0	0	0	0	0	0
Diptera	Chironomidae	Orthoclaadiinae	midge	GC	6	0	0	0	0	1	0
Diptera	Chironomidae	Orthoclaadius cplx.	midge	GC	6	2	2	3	3	0	2
Diptera	Chironomidae	Orthoclaadius sp.	midge	GC	6	0	0	0	0	0	0
Diptera	Chironomidae	Parachironomus sp.	midge	PR	4.1	0	0	1	0	0	0
Diptera	Chironomidae	Parakiefferiella sp.	midge	GC	4.8	0	0	0	0	0	0
Diptera	Chironomidae	Paratanytarsus sp.	midge	GC	6	0	0	4	0	0	0
Diptera	Chironomidae	Paraphaenocladius sp.	midge	GC	4	0	0	0	0	0	0
Diptera	Chironomidae	Paratendipes basidens	midge	GC	8	0	0	0	0	0	0
Diptera	Chironomidae	Pentaneura inconspicua	midge	PR	4.9	0	0	5	0	0	0
Diptera	Chironomidae	Polypedilum flavum	midge	SH	6	22	16	40	36	24	14
Diptera	Chironomidae	Polypedilum sp.	midge	SH	6	0	0	1	0	0	0
Diptera	Chironomidae	Polypedilum tritum	midge	SH	6	0	0	0	0	0	0
Diptera	Chironomidae	Potthastia longimanna	midge	GC	2	0	0	0	0	0	0
Diptera	Chironomidae	Procladius sp.	midge	PR	9	1	0	0	0	0	0
Diptera	Chironomidae	Pseudochironomus sp.	midge	GC	5	0	0	0	0	0	0

Appendix D. Benthic Invertebrate Community Data
Hester Dandy: Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	CR-REF-01-HD1	CR-REF-01-HD2	CR-REF-01-HD3	CR-REF-01-HD4	CR-REF-01-HD5	CR-REF-02-HD1	CR-REF-02-HD2	CR-REF-02-HD3	CR-REF-02-HD4	CR-REF-02-HD5	RA-003-50-HD1	RA-003-50-HD2	RA-003-50-HD3	RA-003-50-HD4	RA-003-50-HD5
Diptera	Chironomidae	Rheotanytarsus sp.	midge	FC	6	316	528	40	112	228	22	60	144	48	40	84	4	16	20	32
Diptera	Chironomidae	Stictochironomus devinctus gr.	midge	OM	5															
Diptera	Chironomidae	Synorthocladius semivirens	midge	GC	2.5															
Diptera	Chironomidae	Tanypodinae	midge	PR	7															
Diptera	Chironomidae	Tanytarsus sp.	midge	FC	6								36		4	8	4			
Diptera	Chironomidae	Thienemanniella xena	midge	GC	3.6	4			4	16	2	26	8	8						
Diptera	Chironomidae	Thienemannimyia gr.	midge	PR	6			8			2		12							
Diptera	Chironomidae	Tribelos jucundum	midge	GC	5.6															
Diptera	Chironomidae	Tvetenia vitracies	midge	GC	5	4	1													
Diptera	Chironomidae	Xenochironomus xenolabis	midge	PR	0															
Diptera	Empididae	Hemerodromia sp.	dance fly	PR	6														1	
Diptera	Psychodidae	Pericoma sp.	moth fly	GC	5.6															
Diptera	Simuliidae	Simulium sp.	black fly	FC	4.8	1														
Diptera	Tabanidae	Chrysops sp.	deer fly	GC	6										1					
Diptera	Tipulidae	Erioptera sp.	crane fly	GC	7															
Diptera	Tipulidae	Tipula sp.	crane fly	SH	7.2								1							

Appendix D. Benthic Invertebrate Community Data
Hester Dandy: Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	RB-012-50-HD1	RB-012-50-HD2	RB-012-50-HD3	RB-012-50-HD4	RB-012-50-HD5	RE-061-00-HD1	RE-061-00-HD2	RE-061-00-HD3	RE-061-00-HD4	RE-061-00-HD5	RE-062-00-HD1	RE-062-00-HD2	RE-062-00-HD3	RE-062-00-HD4	RE-062-00-HD5
Diptera	Chironomidae	Rheotanytarsus sp.	midge	FC	6	24	20	44	20	16	36	196	14	56	20	184	256	176	172	88
Diptera	Chironomidae	Stictochironomus devinctus gr.	midge	OM	5															
Diptera	Chironomidae	Synorthocladius semivirens	midge	GC	2.5															
Diptera	Chironomidae	Tanypodinae	midge	PR	7															
Diptera	Chironomidae	Tanytarsus sp.	midge	FC	6	4	24													4
Diptera	Chironomidae	Thienemanniella xena	midge	GC	3.6	4	4			8	4	12	5	4		12	24	24	8	12
Diptera	Chironomidae	Thienemannimyia gr.	midge	PR	6				4	8					4	4			4	
Diptera	Chironomidae	Tribelos jucundum	midge	GC	5.6															
Diptera	Chironomidae	Tvetenia vitracies	midge	GC	5							4								12
Diptera	Chironomidae	Xenochironomus xenolabis	midge	PR	0															
Diptera	Empididae	Hemerodromia sp.	dance fly	PR	6												2			
Diptera	Psychodidae	Pericoma sp.	moth fly	GC	5.6	1														
Diptera	Simuliidae	Simulium sp.	black fly	FC	4.8											3	3			
Diptera	Tabanidae	Chrysops sp.	deer fly	GC	6															
Diptera	Tipulidae	Erioptera sp.	crane fly	GC	7															
Diptera	Tipulidae	Tipula sp.	crane fly	SH	7.2															

Appendix D. Benthic Invertebrate Community Data
Hester Dandy: Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	RE-073-00-HD1	RE-073-00-HD2	RE-073-00-HD5	RF-082-00-HD1	RF-082-00-HD2	RF-082-00-HD3	RF-082-00-HD4	RF-082-00-HD5	RG-136-00-HD1	RG-136-00-HD2	RG-136-00-HD3	RG-136-00-HD4	RG-136-00-HD5	RG-137-50-HD1	RG-137-50-HD2
Diptera	Chironomidae	Rheotanytarsus sp.	midge	FC	6	1	8	40	7	24	16	8	124	260	176	332	132	60	88	520
Diptera	Chironomidae	Stictochironomus devinctus gr.	midge	OM	5															
Diptera	Chironomidae	Synorthocladius semivirens	midge	GC	2.5															
Diptera	Chironomidae	Tanypodinae	midge	PR	7															
Diptera	Chironomidae	Tanytarsus sp.	midge	FC	6	2	4		4	4	4	4			44					
Diptera	Chironomidae	Thienemanniella xena	midge	GC	3.6	1		4	14		4		8	24	40	36		12		64
Diptera	Chironomidae	Thienemannimyia gr.	midge	PR	6			8						4						
Diptera	Chironomidae	Tribelos jucundum	midge	GC	5.6															
Diptera	Chironomidae	Tvetenia vitracies	midge	GC	5									20					4	16
Diptera	Chironomidae	Xenochironomus xenolabis	midge	PR	0															
Diptera	Empididae	Hemerodromia sp.	dance fly	PR	6															
Diptera	Psychodidae	Pericoma sp.	moth fly	GC	5.6															
Diptera	Simuliidae	Simulium sp.	black fly	FC	4.8								1	5	2	13		1		1
Diptera	Tabanidae	Chrysops sp.	deer fly	GC	6															
Diptera	Tipulidae	Erioptera sp.	crane fly	GC	7															
Diptera	Tipulidae	Tipula sp.	crane fly	SH	7.2															

Appendix D. Benthic Invertebrate Community Data
Hester Dandy: Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	RG-137-50-HD3	RG-137-50-HD4	RG-137-50-HD5	RH-143-00-HD1	RH-143-00-HD2	RH-143-00-HD3	RH-144-50-HD1	RH-144-50-HD2	RH-144-50-HD3	RH-144-50-HD4	RH-144-50-HD5	RH-150-00-HD1	RH-150-00-HD2	RH-150-00-HD3	RH-150-00-HD4
Diptera	Chironomidae	Rheotanytarsus sp.	midge	FC	6	344	312	112	324	188	148	104	304	424	264	200	36	60	116	212
Diptera	Chironomidae	Stictochironomus devinctus gr.	midge	OM	5															
Diptera	Chironomidae	Synorthocladius semivirens	midge	GC	2.5															
Diptera	Chironomidae	Tanypodinae	midge	PR	7											8				
Diptera	Chironomidae	Tanytarsus sp.	midge	FC	6										80					
Diptera	Chironomidae	Thienemanniella xena	midge	GC	3.6	16	64	32	36	8	8	28	8	8	88	16	12	4	16	16
Diptera	Chironomidae	Thienemannimyia gr.	midge	PR	6				8					8	40		4	4	8	
Diptera	Chironomidae	Tribelos jucundum	midge	GC	5.6															
Diptera	Chironomidae	Tvetenia vitracies	midge	GC	5		8				8									
Diptera	Chironomidae	Xenochironomus xenolabis	midge	PR	0															
Diptera	Empididae	Hemerodromia sp.	dance fly	PR	6						1									
Diptera	Psychodidae	Pericoma sp.	moth fly	GC	5.6															
Diptera	Simuliidae	Simulium sp.	black fly	FC	4.8	1		1		2	3	1		2	6	1				
Diptera	Tabanidae	Chrysops sp.	deer fly	GC	6															
Diptera	Tipulidae	Erioptera sp.	crane fly	GC	7															
Diptera	Tipulidae	Tipula sp.	crane fly	SH	7.2															

Appendix D. Benthic Invertebrate Community Data
Hester Dandy: Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	RH-150-00-HD5	RI-164-00-HD1	RI-164-00-HD2	RI-164-00-HD3	RI-164-00-HD4	RI-164-00-HD5	RI-164-50-HD1	RI-164-50-HD2	RI-164-50-HD3	RI-164-50-HD4	RI-164-50-HD5	RI-168-50-HD1	RI-168-50-HD2	RI-168-50-HD3	RI-168-50-HD4
Diptera	Chironomidae	Rheotanytarsus sp.	midge	FC	6	92	68	64	200	10	39	4	32	16	36	24	88	100	108	36
Diptera	Chironomidae	Stictochironomus devinctus gr.	midge	OM	5															
Diptera	Chironomidae	Synorthocladius semivirens	midge	GC	2.5															
Diptera	Chironomidae	Tanypodinae	midge	PR	7															
Diptera	Chironomidae	Tanytarsus sp.	midge	FC	6							4			24					
Diptera	Chironomidae	Thienemanniella xena	midge	GC	3.6	16		8	48		1			12	4		16	24	4	8
Diptera	Chironomidae	Thienemannimyia gr.	midge	PR	6															
Diptera	Chironomidae	Tribelos jucundum	midge	GC	5.6															
Diptera	Chironomidae	Tvetenia vitracies	midge	GC	5					3										
Diptera	Chironomidae	Xenochironomus xenolabis	midge	PR	0															
Diptera	Empididae	Hemerodromia sp.	dance fly	PR	6												1			
Diptera	Psychodidae	Pericoma sp.	moth fly	GC	5.6											1				
Diptera	Simuliidae	Simulium sp.	black fly	FC	4.8						1				1	3	3	19	2	
Diptera	Tabanidae	Chrysops sp.	deer fly	GC	6															
Diptera	Tipulidae	Erioptera sp.	crane fly	GC	7															
Diptera	Tipulidae	Tipula sp.	crane fly	SH	7.2															

Appendix D. Benthic Invertebrate Community Data
Hester Dandy: Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	RI-168-50-HD5	RK-201-00-HD1	RK-201-00-HD2	RK-201-00-HD3	RK-201-00-HD4	RK-201-00-HD5	RM-285-00-HD1	RM-285-00-HD2	RM-285-00-HD3	RM-285-00-HD4	RM-285-00-HD5	TR-REF-01-HD1	TR-REF-01-HD2	TR-REF-01-HD3	TR-REF-01-HD4
Diptera	Chironomidae	Rheotanytarsus sp.	midge	FC	6	60	36	28	32	8	26	144	88	72	48	32	4	1	3	5
Diptera	Chironomidae	Stictochironomus devinctus gr.	midge	OM	5		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	Synorthocladius semivirens	midge	GC	2.5		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	Tanypodinae	midge	PR	7		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	Tanytarsus sp.	midge	FC	6		0	0	0	0	0	0	0	0	0	24	0	0	0	0
Diptera	Chironomidae	Thienemanniella xena	midge	GC	3.6	8	24	4	12	4	10	20	8	24	36	16	1	2	4	1
Diptera	Chironomidae	Thienemannimyia gr.	midge	PR	6		0	0	0	4	0	0	0	0	0	0	1	0	2	0
Diptera	Chironomidae	Tribelos jucundum	midge	GC	5.6		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	Tvetenia vitracies	midge	GC	5		4	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Chironomidae	Xenochironomus xenolabis	midge	PR	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Empididae	Hemerodromia sp.	dance fly	PR	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Psychodidae	Pericoma sp.	moth fly	GC	5.6		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Simuliidae	Simulium sp.	black fly	FC	4.8	1	1	1	0	0	1	2	0	1	0	0	0	0	0	0
Diptera	Tabanidae	Chrysops sp.	deer fly	GC	6		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Tipulidae	Erioptera sp.	crane fly	GC	7		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diptera	Tipulidae	Tipula sp.	crane fly	SH	7.2		0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix D. Benthic Invertebrate Community Data
Hester Dandy: Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	TR-REF-01-HD5	TR-REF-02-HD1	TR-REF-02-HD2	TR-REF-02-HD3	TR-REF-02-HD4	TR-REF-02-HD5
Diptera	Chironomidae	Rheotanytarsus sp.	midge	FC	6	7	2	10	7	4	8
Diptera	Chironomidae	Stictochironomus devinctus gr.	midge	OM	5	0	0	0	0	0	0
Diptera	Chironomidae	Synorthocladius semivirens	midge	GC	2.5	0	0	0	0	0	0
Diptera	Chironomidae	Tanypodinae	midge	PR	7	0	0	0	0	0	0
Diptera	Chironomidae	Tanytarsus sp.	midge	FC	6	0	0	0	0	0	0
Diptera	Chironomidae	Thienemanniella xena	midge	GC	3.6	1	0	0	0	0	0
Diptera	Chironomidae	Thienemannimyia gr.	midge	PR	6	1	2	2	3	4	0
Diptera	Chironomidae	Tribelos jucundum	midge	GC	5.6	0	0	0	0	0	0
Diptera	Chironomidae	Tvetenia vitracies	midge	GC	5	0	0	0	0	0	0
Diptera	Chironomidae	Xenochironomus xenolabis	midge	PR	0	0	0	0	0	0	0
Diptera	Empididae	Hemerodromia sp.	dance fly	PR	6	0	0	0	0	0	0
Diptera	Psychodidae	Pericoma sp.	moth fly	GC	5.6	0	0	0	0	0	0
Diptera	Simuliidae	Simulium sp.	black fly	FC	4.8	0	0	0	0	0	0
Diptera	Tabanidae	Chrysops sp.	deer fly	GC	6	0	0	0	0	0	0
Diptera	Tipulidae	Erioptera sp.	crane fly	GC	7	0	0	0	0	0	0
Diptera	Tipulidae	Tipula sp.	crane fly	SH	7.2	0	0	0	0	0	0

Appendix D. Benthic Invertebrate Community Data
Hester Dandy: Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	CR-REF-01-HD1	CR-REF-01-HD2	CR-REF-01-HD3	CR-REF-01-HD4	CR-REF-01-HD5	CR-REF-02-HD1	CR-REF-02-HD2	CR-REF-02-HD3	CR-REF-02-HD4	CR-REF-02-HD5	RA-003-50-HD1	RA-003-50-HD2	RA-003-50-HD3	RA-003-50-HD4	RA-003-50-HD5
Metrics:																				
			Filterers/Collectors Abundance			343	589	47	116	239	36	64	190	60	47	93	14	21	68	82
			Total Abundance			563	712	255	198	412	182	278	502	441	254	267	218	286	295	660
			Hilsenhoff Sum			3195	3954	1785	1134	2367	1078	1714	3204	3006	1613	1593	1661	1690	1669	4225
			Mayfly Abundance			30	33	27	6	25	35	19	14	29	30	16	6	11	8	13
			Caddisfly Abundance			28	63	7	5	9	5	2	18	11	6	6	6	8	1	7
			Isopods, Snails, Leeches Abundance			0	0	2	1	2	1	0	4	5	11	2	2	1	1	2
			Surface Dependent Abundance			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Taxa Richness			32	33	23	21	29	29	30	33	35	35	30	26	32	27	27
			# of Mayfly Taxa			7	8	4	3	8	8	6	8	6	5	4	2	5	3	4
			# of Stonefly Taxa			2	2	3	1	3	2	3	2	3	1	2	1	3	2	2
			# of Caddisfly Taxa			6	9	2	4	2	4	2	7	6	5	3	2	4	1	2
			% Mayfly Comp			5.3	4.6	10.6	3.0	6.1	19.2	6.8	2.8	6.6	11.8	6.0	2.8	3.8	2.7	2.0
			% Caddisfly Comp			5.0	8.8	2.7	2.5	2.2	2.7	0.7	3.6	2.5	2.4	2.2	2.8	2.8	0.3	1.1
			% Dominant Taxon			56.1	74.2	28.2	56.6	55.3	24.2	21.6	28.7	21.8	18.9	31.5	27.5	12.6	23.1	39.4
			% Isopods, Snails, Leeches			0.0	0.0	0.8	0.5	0.5	0.5	0.0	0.8	1.1	4.3	0.7	0.9	0.3	0.3	0.3
			% Surface Dependent			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			HBI			5.68	5.55	7.00	5.73	5.75	5.92	6.17	6.38	6.82	6.35	5.97	7.62	5.91	5.66	6.40
			Ratio Filterers/Total			0.61	0.83	0.18	0.59	0.58	0.20	0.23	0.38	0.14	0.19	0.35	0.06	0.07	0.23	0.12
			EPT Index			15	19	9	8	13	14	11	17	15	11	9	5	12	6	8

Appendix D. Benthic Invertebrate Community Data
Hester Dandy: Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	RB-012-50-HD1	RB-012-50-HD2	RB-012-50-HD3	RB-012-50-HD4	RB-012-50-HD5	RE-061-00-HD1	RE-061-00-HD2	RE-061-00-HD3	RE-061-00-HD4	RE-061-00-HD5	RE-062-00-HD1	RE-062-00-HD2	RE-062-00-HD3	RE-062-00-HD4	RE-062-00-HD5
Metrics:																				
			Filterers/Collectors Abundance			67	53	134	48	60	93	265	23	113	61	253	369	214	232	125
			Total Abundance			374	253	473	394	358	501	666	95	387	336	725	777	703	808	562
			Hilsenhoff Sum			2248	1702	3004	2384	2044	2877	4007	572	2439	2006	3205	4055	3265	4129	3442
			Mayfly Abundance			3	4	4	2	3	13	12	1	3	8	29	65	42	34	11
			Caddisfly Abundance			4	1	4	2	6	53	60	9	53	36	68	111	33	48	35
			Isopods, Snails, Leeches Abundance			17	3	12	9	4	1	1	3	3	4	2	1	6	4	2
			Surface Dependent Abundance			1	0	0	0	0	0	0	0	0	0	1	1	0	0	0
			Taxa Richness			26	24	24	21	21	32	31	22	29	29	35	41	37	37	38
			# of Mayfly Taxa			2	3	3	2	2	5	3	1	2	3	5	6	8	5	5
			# of Stonefly Taxa			0	0	0	0	1	2	2	1	2	1	3	3	2	2	3
			# of Caddisfly Taxa			3	1	3	1	4	7	5	2	5	4	6	9	7	6	7
			% Mayfly Comp			0.8	1.6	0.8	0.5	0.8	2.6	1.8	1.1	0.8	2.4	4.0	8.4	6.0	4.2	2.0
			% Caddisfly Comp			1.1	0.4	0.8	0.5	1.7	10.6	9.0	9.5	13.7	10.7	9.4	14.3	4.7	5.9	6.2
			% Dominant Taxon			22.5	34.8	41.4	26.4	40.2	33.5	29.4	22.1	22.7	27.4	26.5	32.9	25.0	21.3	33.1
			% Isopods, Snails, Leeches			4.5	1.2	2.5	2.3	1.1	0.2	0.2	3.2	0.8	1.2	0.3	0.1	0.9	0.5	0.4
			% Surface Dependent			0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0
			HBI			6.01	6.73	6.35	6.05	5.71	5.74	6.02	6.02	6.30	5.97	4.42	5.22	4.64	5.11	6.12
			Ratio Filterers/Total			0.18	0.21	0.28	0.12	0.17	0.19	0.40	0.24	0.29	0.18	0.35	0.47	0.30	0.29	0.22
			EPT Index			5	4	6	3	7	14	10	4	9	8	14	18	17	13	15

Appendix D. Benthic Invertebrate Community Data
Hester Dandy: Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	RE-073-00-HD1	RE-073-00-HD2	RE-073-00-HD5	RF-082-00-HD1	RF-082-00-HD2	RF-082-00-HD3	RF-082-00-HD4	RF-082-00-HD5	RG-136-00-HD1	RG-136-00-HD2	RG-136-00-HD3	RG-136-00-HD4	RG-136-00-HD5	RG-137-50-HD1	RG-137-50-HD2
Metrics:																				
			Filterers/Collectors Abundance			45	129	59	17	29	71	14	199	301	285	436	143	74	125	551
			Total Abundance			363	825	614	341	180	221	321	430	942	854	1336	669	478	534	1613
			Hilsenhoff Sum			2386	5617	3865	2325	1144	1308	1945	2268	4939	4291	6568	3818	2643	3473	10385
			Mayfly Abundance			1	2	6	1	1	0	1	14	29	40	56	15	11	14	18
			Caddisfly Abundance			4	11	19	3	0	3	3	63	34	49	90	12	13	33	20
			Isopods, Snails, Leeches Abundance			1	2	1	9	0	0	1	1	15	12	7	35	18	1	0
			Surface Dependent Abundance			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Taxa Richness			28	26	30	25	23	16	19	27	32	29	32	28	25	25	28
			# of Mayfly Taxa			1	1	4	1	1	0	1	4	5	4	6	4	4	3	3
			# of Stonefly Taxa			1	1	1	1	2	2	1	1	1	2	2	2	1	2	2
			# of Caddisfly Taxa			3	2	4	3	0	1	3	6	4	5	7	5	4	4	5
			% Mayfly Comp			0.3	0.2	1.0	0.3	0.6	0.0	0.3	3.3	3.1	4.7	4.2	2.2	2.3	2.6	1.1
			% Caddisfly Comp			1.1	1.3	3.1	0.9	0.0	1.4	0.9	14.7	3.6	5.7	6.7	1.8	2.7	6.2	1.2
			% Dominant Taxon			50.7	42.2	37.8	48.1	23.9	21.7	33.6	28.8	27.6	24.4	29.7	21.5	24.3	39.7	33.2
			% Isopods, Snails, Leeches			0.3	0.2	0.2	2.6	0.0	0.0	0.3	0.2	1.6	1.4	0.5	5.2	3.8	0.2	0.0
			% Surface Dependent			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			HBI			6.57	6.81	6.29	6.82	6.36	5.92	6.06	5.27	5.24	5.02	4.92	5.71	5.53	6.50	6.44
			Ratio Filterers/Total			0.12	0.16	0.10	0.05	0.16	0.32	0.04	0.46	0.32	0.33	0.33	0.21	0.15	0.23	0.34
			EPT Index			5	4	9	5	3	3	5	11	10	11	15	11	9	9	10

Appendix D. Benthic Invertebrate Community Data
Hester Dandy: Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	RG-137-50-HD3	RG-137-50-HD4	RG-137-50-HD5	RH-143-00-HD1	RH-143-00-HD2	RH-143-00-HD3	RH-144-50-HD1	RH-144-50-HD2	RH-144-50-HD3	RH-144-50-HD4	RH-144-50-HD5	RH-150-00-HD1	RH-150-00-HD2	RH-150-00-HD3	RH-150-00-HD4
Metrics:																				
			Filterers/Collectors Abundance			350	344	146	358	232	270	116	353	471	370	220	49	92	122	218
			Total Abundance			1108	1181	734	901	747	1098	766	1003	1409	1316	914	424	619	809	815
			Hilsenhoff Sum			7310	7619	4873	5202	4963	7000	5118	6262	9330	7909	5325	3056	4445	5516	5519
			Mayfly Abundance			29	17	35	15	15	32	24	34	30	32	26	2	8	13	12
			Caddisfly Abundance			5	31	11	26	35	46	7	31	8	11	19	1	0	3	2
			Isopods, Snails, Leeches Abundance			1	4	7	0	2	2	0	0	1	0	2	0	1	1	2
			Surface Dependent Abundance			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Taxa Richness			22	26	28	24	28	39	21	18	29	25	25	17	22	27	19
			# of Mayfly Taxa			4	5	6	5	5	6	4	6	2	4	5	2	4	4	3
			# of Stonefly Taxa			2	2	2	2	2	1	2	1	2	2	2	1	2	2	1
			# of Caddisfly Taxa			2	5	7	7	7	8	2	3	6	3	3	1	0	3	2
			% Mayfly Comp			2.6	1.4	4.8	1.7	2.0	2.9	3.1	3.4	2.1	2.4	2.8	0.5	1.3	1.6	1.5
			% Caddisfly Comp			0.5	2.6	1.5	2.9	4.7	4.2	0.9	3.1	0.6	0.8	2.1	0.2	0.0	0.4	0.2
			% Dominant Taxon			42.6	38.6	46.9	36.0	51.9	42.6	58.0	37.5	36.3	29.2	30.6	57.5	55.6	48.0	47.1
			% Isopods, Snails, Leeches			0.1	0.3	1.0	0.0	0.3	0.2	0.0	0.0	0.1	0.0	0.2	0.0	0.2	0.1	0.2
			% Surface Dependent			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
			HBI			6.60	6.45	6.64	5.77	6.64	6.38	6.68	6.24	6.62	6.01	5.83	7.21	7.18	6.82	6.77
			Ratio Filterers/Total			0.32	0.29	0.20	0.40	0.31	0.25	0.15	0.35	0.33	0.28	0.24	0.12	0.15	0.15	0.27
			EPT Index			8	12	15	14	14	15	8	10	10	9	10	4	6	9	6

Appendix D. Benthic Invertebrate Community Data
Hester Dandy: Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	RH-150-00-HD5	RI-164-00-HD1	RI-164-00-HD2	RI-164-00-HD3	RI-164-00-HD4	RI-164-00-HD5	RI-164-50-HD1	RI-164-50-HD2	RI-164-50-HD3	RI-164-50-HD4	RI-164-50-HD5	RI-168-50-HD1	RI-168-50-HD2	RI-168-50-HD3	RI-168-50-HD4
Metrics:																				
			Filterers/Collectors Abundance			137	84	86	288	36	74	42	33	46	126	27	124	153	131	98
			Total Abundance			811	667	789	1716	155	175	655	591	732	670	548	521	809	599	426
			Hilsenhoff Sum			5476	4710	5702	11691	1022	1047	4768	4502	5141	4633	4021	3407	5635	3936	2753
			Mayfly Abundance			18	13	11	32	8	5	2	2	1	1	0	3	6	2	3
			Caddisfly Abundance			17	8	14	63	17	11	0	0	1	1	0	17	23	17	46
			Isopods, Snails, Leeches Abundance			4	0	0	0	0	0	4	13	9	4	7	14	14	33	15
			Surface Dependent Abundance			0	0	0	0	0	0	0	0	1	0	0	1	0	0	0
			Taxa Richness			25	22	23	31	26	23	24	21	27	21	17	26	25	30	24
			# of Mayfly Taxa			3	4	3	8	5	2	2	2	1	1	0	2	2	2	2
			# of Stonefly Taxa			1	1	2	1	1	1	0	0	1	1	0	1	1	1	1
			# of Caddisfly Taxa			4	5	4	8	6	5	0	0	1	1	0	2	3	4	6
			% Mayfly Comp			2.2	1.9	1.4	1.9	5.2	2.9	0.3	0.3	0.1	0.1	0.0	0.6	0.7	0.3	0.7
			% Caddisfly Comp			2.1	1.2	1.8	3.7	11.0	6.3	0.0	0.0	0.1	0.1	0.0	3.3	2.8	2.8	10.8
			% Dominant Taxon			51.3	61.2	63.9	56.4	49.0	29.1	56.2	65.7	59.0	51.3	59.1	26.9	47.0	19.4	27.2
			% Isopods, Snails, Leeches			0.5	0.0	0.0	0.0	0.0	0.0	0.6	2.2	1.2	0.6	1.3	2.7	1.7	5.5	3.5
			% Surface Dependent			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.2	0.0	0.0	0.0
			HBI			6.75	7.06	7.23	6.81	6.59	5.98	7.28	7.62	7.02	6.91	7.34	6.54	6.97	6.57	6.46
			Ratio Filterers/Total			0.17	0.13	0.11	0.17	0.23	0.42	0.06	0.06	0.06	0.19	0.05	0.24	0.19	0.22	0.23
			EPT Index			8	10	9	17	12	8	2	2	3	3	0	5	6	7	9

Appendix D. Benthic Invertebrate Community Data
Hester Dandy: Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	RI-168-50-HD5	RK-201-00-HD1	RK-201-00-HD2	RK-201-00-HD3	RK-201-00-HD4	RK-201-00-HD5	RM-285-00-HD1	RM-285-00-HD2	RM-285-00-HD3	RM-285-00-HD4	RM-285-00-HD5	TR-REF-01-HD1	TR-REF-01-HD2	TR-REF-01-HD3	TR-REF-01-HD4
Metrics:											58	268	219	116	89	79	23	17	49	21
											289	515	584	357	454	330	184	205	345	137
											1712	2964	3146	1664	2521	1834	850	838	1290	561
											9	10	6	5	4	4	21	32	28	17
											22	123	133	43	29	19	10	24	45	12
											0	0	0	0	1	0	2	3	1	4
											0	0	0	0	0	0	0	0	0	0
											20	16	18	20	20	24	28	23	26	25
											4	3	3	2	4	3	3	2	3	3
											1	1	1	2	1	2	1	1	2	1
											3	4	4	4	5	3	4	6	7	4
											3.1	1.9	1.0	1.4	0.9	1.2	11.4	15.6	8.1	12.4
											7.6	23.9	22.8	12.0	6.4	5.8	5.4	11.7	13.0	8.8
											32.5	28.0	21.9	27.2	29.1	25.5	26.1	35.1	38.6	24.1
											0.0	0.0	0.0	0.0	0.2	0.0	1.1	1.5	0.3	2.9
											0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
											5.92	5.75	5.39	4.66	5.55	5.56	4.62	4.09	3.74	4.09
											0.21	0.32	0.16	0.16	0.09	0.20	0.13	0.08	0.14	0.15
											0.20	0.52	0.38	0.32	0.20	0.24	0.13	0.08	0.14	0.15
											8	8	8	8	10	8	8	9	12	8

- Notes:
- EPT

Ephemeroptera, Plecoptera, and Trichoptera
- FC

Filterer/Collector
- GC

Gatherer/Collector
- HBI

Hilsenhoff Biotic Index
- OM

Omnivore
- PA

Parasite
- PR

Predator
- SC

Scraper
- SH

Shredder
- #

Number
- %

Percent

Appendix D. Benthic Invertebrate Community Data
Hester Dandy: Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	TR-REF-01-HD5	TR-REF-02-HD1	TR-REF-02-HD2	TR-REF-02-HD3	TR-REF-02-HD4	TR-REF-02-HD5
Metrics:											
			Filterers/Collectors Abundance			29	29	112	88	57	23
			Total Abundance			160	262	478	409	279	90
			Hilsenhoff Sum			737	1043	2064	1663	1199	436
			Mayfly Abundance			36	87	144	162	120	22
			Caddisfly Abundance			25	27	101	80	51	14
			Isopods, Snails, Leeches Abundance			1	5	3	2	1	0
			Surface Dependent Abundance			0	0	0	0	0	0
			Taxa Richness			25	27	34	23	23	17
			# of Mayfly Taxa			3	4	5	2	3	2
			# of Stonefly Taxa			1	2	2	1	1	1
			# of Caddisfly Taxa			4	5	6	6	6	4
			% Mayfly Comp			22.5	33.2	30.1	39.6	43.0	24.4
			% Caddisfly Comp			15.6	10.3	21.1	19.6	18.3	15.6
			% Dominant Taxon			15.0	29.4	23.8	38.6	37.3	20.0
			% Isopods, Snails, Leeches			0.6	1.9	0.6	0.5	0.4	0.0
			% Surface Dependent			0.0	0.0	0.0	0.0	0.0	0.0
			HBI			4.61	3.98	4.32	4.07	4.30	4.84
			Ratio Filterers/Total			0.18	0.11	0.23	0.22	0.20	0.26
			EPT Index			8	11	13	9	10	7

Appendix E-1:
Benthic Invertebrate Community Data
Sweeps (EPA)

Appendix E1. Benthic Invertebrate Community Data-Sweeps (EPA): Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	CR-Ref-01-IC-SP1	CR-Ref-02-IC-SP1	RA-Ref-01-IC-SP1	RB-013-00-IC-SP1	RE-062-00-IC-SP1	RE-077-50-IC-SP1	RF-085-00-IC-SP1	RG-140-00-IC-SP1	RH-153-50-IC-SP1	RI-169-50-IC-SP1	RK-201-00-IC-SP1	RM-285-00-IC-SP1	TR-Ref-01-SP1	TR-Ref-02-SP1
Nematoda			round worm	PA	9	1						1	5				1		2
Tricladida	Planariidae	<i>Dugesia tigrina</i>	flat worm	PR	6				1						7		2	3	2
Hoplonemertea	Tetrastemmatidae	<i>Prostoma graecense</i>	proboscis worm	PR	8						2			1					
Hirudinea	Glossiphoniidae	<i>Helobdella elongata</i>	leech	PR	8		2												
Hirudinea	Glossiphoniidae	<i>Helobdella fusca</i>	leech	PA	8				2										1
Hirudinea	Glossiphoniidae	<i>Helobdella stagnalis</i>	leech	PR	8														
Tubificida	Naididae	<i>Dero obtusa</i>	naiad worm	GC	10											3			
Tubificida	Naididae	<i>Nais bretscheri</i>	naiad worm	GC	6												2		
Tubificida	Naididae	<i>Nais sp.</i>	naiad worm	GC	8				24		13			1	7	5	8		
Tubificida	Naididae	<i>Pristina longisoma</i>	naiad worm	GC	9.9											3			
Tubificida	Naididae	<i>Slavina appendiculata</i>	naiad worm	GC	6														
Tubificida	Naididae	<i>Stylaria lacustris</i>	naiad worm	GC	6														
Tubificida	Enchytraeidae		aquatic worm	GC	10								2						
Tubificida	Tubificidae	<i>Branchiura sowerbyi</i>	tube worm	GC	6			1	1		1				7				
Tubificida	Tubificidae	<i>Limnodrilus hoffmeisteri</i>	tube worm	GC	10				14										
Tubificida	Tubificidae	<i>Limnodrilus sp.</i>	tube worm	GC	10								6						
Tubificida	Tubificidae	<i>immature with hair chaetae</i>	tube worm	GC	10												4		
Hydroida	Hydridae	<i>Hydra sp.</i>	polyp	PR	5														
Basommatophora	Ancylidae	<i>Ferrissia rivularis</i>	limpet snail	SC	7	1	20	11	34	1	13	4	11	60	9	5	18	21	30
Basommatophora	Lymnaeidae	<i>Fossaria sp.</i>	pond snail	SC	2.6	1	5	1	8									4	
Basommatophora	Physidae	<i>Physa sp.</i>	pouch snail	SC	9	11	20	3	12			1						3	4
Basommatophora	Planorbidae	<i>Gyraulus parvus</i>	ram's horn snail	SC	5.5			1											
Basommatophora	Planorbidae	<i>Helisoma sp.</i>	ram's horn snail	SC	7		1		4	1									
Basommatophora	Hydrobiidae	<i>Amnicola sp.</i>	dusky snail	SC	4							1							
Mesogastropoda	Pleuroceridae	<i>Goniobasis livescens</i>	horn snail	SC	6	1				3	1			6	22		10	5	8
Mesogastropoda	Pleuroceridae	<i>Leptoxis carinata</i>	horn snail	SC	6														
Veneroida	Dreissenidae	<i>Dreissena polymorpha</i>	zebra mussel	FC	8			4	16	11	6		1	11	34	10	8	13	4
Veneroida	Sphaeriidae	<i>Pisidium sp.</i>	pill clam	FC	4.6						2				1			4	3
Hydracarina			water mite	PR	6			1	3	12	1	7		3			3		
Amphipoda	Crangonyctidae	<i>Crangonyx sp.</i>	sideswimmer	GC	4														
Amphipoda	Gammaridae	<i>Gammarus fasciatus</i>	sideswimmer	GC	3	18	296	4	75	16	1		2	3		1		115	25
Amphipoda	Hyalellidae	<i>Hyalella azteca</i>	sideswimmer	GC	8	2		168	14		1		2				1	1	
Decapoda	Cambaridae	<i>Orconectes sp.</i>	crayfish	GC	5		24												
Isopoda	Asellidae	<i>Caecidotea sp.</i>	sowbug	GC	6				1			1			1				
Ephemeroptera	Baetidae	<i>Acerpenna sp.</i>	mayfly	SH	4														4
Ephemeroptera	Baetidae	<i>Baetis sp.</i>	mayfly	GC	3.1	1		3	1		2							1	
Ephemeroptera	Baetidae	<i>Centroptilum sp.</i>	mayfly	GC	2														
Ephemeroptera	Baetidae	<i>Plauditus sp.</i>	mayfly	GC	4	58	2			14	1	2		2	9			20	1
Ephemeroptera	Baetiscidae	<i>Baetisca sp.</i>	mayfly	GC	4	3	40		8	8	2	9	1		2		1	5	
Ephemeroptera	Caenidae	<i>Caenis sp.</i>	mayfly	GC	7	1	8	1		4	1	1	2	1		59	4	4	16
Ephemeroptera	Ephemeridae	<i>Ephemera sp.</i>	mayfly	CG	1														2
Ephemeroptera	Ephemeridae	<i>Hexagenia sp.</i>	mayfly	GC	6														
Ephemeroptera	Ephemerellidae	<i>Serratella sp.</i>	mayfly	GC	0.6														
Ephemeroptera	Heptageniidae	<i>Maccaffertium mediopunctatum</i>	mayfly	SC	3														
Ephemeroptera	Heptageniidae	<i>Maccaffertium sp.</i>	mayfly	SC	4	29	24		2	16		1	9	73	1	10	16	33	144
Ephemeroptera	Heptageniidae	<i>Stenacron interpunctatum</i>	mayfly	OM	7		24		5							1		1	4
Ephemeroptera	Heptageniidae	<i>Stenonema femoratum</i>	mayfly	OM	5											1			
Ephemeroptera	Isonychiidae	<i>Isonychia sp.</i>	mayfly	FC	2						1		1				1		
Ephemeroptera	Leptophlebiidae	<i>Leptophlebia sp.</i>	mayfly	GC	4		16	1	1		1			8		8		3	
Ephemeroptera	Potamanthidae	<i>Anthopotamus verticis gr.</i>	mayfly	GC	3.2	2		1	4		6	11	11	8	1		1	1	
Ephemeroptera	Tricorythidae	<i>Tricorythodes sp.</i>	mayfly	GC	4	42	200	2	1	92	15	11	15	187	9	24	68	5	20
Odonata	Aeshnidae	<i>Aeshna sp.</i>	dragonfly	PR	4										1				
Odonata	Aeshnidae	<i>Boyeria vinosa</i>	dragonfly	PR	3.5														
Odonata	Calopterygidae	<i>Haeterina sp.</i>	damselfly	PR	6	2	3						2		1				
Odonata	Coenagrionidae	<i>Argia sp.</i>	damselfly	PR	5.1	2		2		5	1				1	1		1	
Odonata	Coenagrionidae	<i>Enallagma sp.</i>	damselfly	PR	9	3	27	16	20	4	5	1	2	5	25	9	29		
Odonata	Corduliidae	<i>Neurocordulia sp.</i>	dragonfly	PR	3														
Odonata	Gomphidae		dragonfly	PR	4					2						1			
Odonata	Gomphidae	<i>Gomphus sp.</i>	dragonfly	PR	5														
Plecoptera	Capniidae	<i>Allocapnia</i>	stonefly	SH	3														
Plecoptera	Chloroperlidae	<i>Haploperla brevis</i>	stonefly	PR	1														
Plecoptera	Perlidae	<i>Acroneuria sp.</i>	stonefly	PR	1														
Plecoptera	Perlidae	<i>Paragnetina sp.</i>	stonefly	PR	2.1		1												
Plecoptera	Taeniopterygidae	<i>Taeniopteryx sp.</i>	stonefly	SH	2	1					8	10		8		8	1	14	5
Megaloptera	Sialidae	<i>Sialis sp.</i>	alderfly	PR	4													1	
Hemiptera	Belostomatidae	<i>Belostoma lutarium</i>	giant water bug	PR	9		1	3										1	
Hemiptera	Corixidae		water boatmen	PR	5											1			
Hemiptera	Corixidae	<i>Hesperocorixa sp.</i>	water boatmen	PR	5				1										
Hemiptera	Corixidae	<i>Sigara lineata</i>	water boatmen	GC	8		10												
Trichoptera	Brachycentridae	<i>Brachycentrus sp.</i>	caddisfly	FC	1	12	14			5	2	6	4	5	3	3	1		
Trichoptera	Glossosomatidae	<i>Protoptila sp.</i>	caddisfly	SC	1													10	10
Trichoptera	Helicopsychidae	<i>Helicopsyche borealis</i>	caddisfly	SC	3	1													
Trichoptera	Hydropsychidae	<i>Cheumatopsyche sp.</i>	caddisfly	FC	5	68	192	1	2	248	11	28	104	60	12	46	132	24	44
Trichoptera	Hydropsychidae	<i>Hydropsyche aerata</i>	caddisfly	FC	2.6	12	8			72	1	16	4	1			4	32	68
Trichoptera	Hydropsychidae	<i>Hydropsyche bronta</i>	caddisfly	FC	5														
Trichoptera	Hydropsychidae	<i>Hydropsyche morosa</i>	caddisfly	FC	2														
Trichoptera	Hydropsychidae	<i>Hydropsyche phalerata</i>	caddisfly	FC	1	92	96			156	2	101	4	17	9	2		44	68
Trichoptera	Hydropsychidae	<i>Hydropsyche sparna</i>	caddisfly	FC	1														

Appendix E1. Benthic Invertebrate Community Data-Sweeps (EPA): Data and Metric Calculations

Trichoptera	Hydropsychidae	<i>Hydropsyche sp.</i>	caddisfly	FC	5	20	128		2	176	34	52	20	16	13	20	72	233	28
Trichoptera	Hydroptilidae	<i>Hydroptilia sp.</i>	caddisfly	PR	6						1		2	1		1			
Trichoptera	Hydroptilidae	<i>Ithytrichia clavata</i>	caddisfly	SC	1		1												
Trichoptera	Lepidostomatidae	<i>Lepidostoma sp.</i>	caddisfly	SH	1														
Trichoptera	Leptoceridae	<i>Nectopsyche sp.</i>	caddisfly	SH	2.4	6	7		3	22	1		2	9	4	2	1	11	13
Trichoptera	Leptoceridae	<i>Oecetis sp.</i>	caddisfly	PR	8	3	8		2	3			1	1	1			9	5
Trichoptera	Leptoceridae	<i>Triaenodes sp.</i>	caddisfly	SH	3														
Trichoptera	Limnephilidae	<i>Pycnopsyche sp.</i>	caddisfly	SH	3.3														
Trichoptera	Polycentropodidae	<i>Cymellus fraternus</i>	caddisfly	FC	8					1				1		4			
Trichoptera	Polycentropodidae	<i>Neureclipsis sp.</i>	caddisfly	FC	7	1								2					
Trichoptera	Polycentropodidae	<i>Polycentropus sp.</i>	caddisfly	PR	6		2	1					1			1			
Trichoptera	Uenoidae	<i>Neophylax sp.</i>	caddisfly	SC	3										1				
Lepidoptera	Pyrilidae	<i>Parapoynx sp.</i>	moth	SH	5	5	25	4		3	8	2		4	1	4		9	23
Lepidoptera	Pyrilidae	<i>Petrophila sp.</i>	moth	SC	2.7	2				11		2		2			4	17	16
Coleoptera	Dytiscidae	<i>Hydroporus sp.</i>	diving beetle	PR	4.1			3											
Coleoptera	Elmidae	<i>Ancyronyx variegatus</i>	riffle beetle	OM	4					4									
Coleoptera	Elmidae	<i>Dubirapha vittata</i>	riffle beetle	OM	7	10	16		29	173	19	3	6	27	25	19	32	35	127
Coleoptera	Elmidae	<i>Macronychus glabratus</i>	riffle beetle	OM	4	13	2		2	45			10	10	3	2	5	1	
Coleoptera	Elmidae	<i>Optioservus sp.</i>	riffle beetle	SC	4					11		1				3	3		
Coleoptera	Elmidae	<i>Stenelmis crenata gr.</i>	riffle beetle	SC	5	31	2	3	1	66	22	8	3	10	1	3	5	16	64
Coleoptera	Gyrinidae	<i>Dineutus sp.</i>	whirligig beetle	PR	3.7														
Coleoptera	Halplidae	<i>Halplus sp.</i>	crawling beetle	SH	5		2												
Coleoptera	Hydrophilidae	<i>Berosus sp.</i>	scavenger beetle	PR	6.7		1									1			
Coleoptera	Psephenidae	<i>Ectopria nervosus</i>	false water penny	SC	5			3											
Coleoptera	Psephenidae	<i>Psephenus herricki</i>	water penny	SC	4													4	
Diptera	Athericidae	<i>Atherix sp.</i>	watersnipe fly	PR	4														
Diptera	Ceratopogonidae	<i>Bezzia sp.</i>	biting midge	GC	6			1											
Diptera	Ceratopogonidae	<i>Ceratopogon sp.</i>	biting midge	PR	6														
Diptera	Ceratopogonidae	<i>Dasyhelea sp.</i>	biting midge	PR	6										4				
Diptera	Ceratopogonidae	<i>Palpomyia gr.</i>	biting midge	PR	6														
Diptera	Ceratopogonidae	<i>Probezzia sp.</i>	biting midge	PR	6														
Diptera	Chironomidae	<i>Ablabesmyia janta</i>	midge	OM	4.9											4			
Diptera	Chironomidae	<i>Ablabesmyia mallochi</i>	midge	OM	8														
Diptera	Chironomidae	Chironomini	midge	GC	6														
Diptera	Chironomidae	<i>Chironomus sp.</i>	midge	GC	10						8					32	36		
Diptera	Chironomidae	<i>Cladotanytarsus sp.</i>	midge	GC	7														
Diptera	Chironomidae	<i>Corynoneura sp.</i>	midge	GC	7		24	72	16										
Diptera	Chironomidae	<i>Cricotopus bicintus</i>	midge	OM	6.7	36	200	4	12	52	144	96	112	344	140	180	68	16	
Diptera	Chironomidae	<i>Cricotopus sp.</i>	midge	SH	7														
Diptera	Chironomidae	<i>Cricotopus trifasciata</i>	midge	OM	7														
Diptera	Chironomidae	<i>Cryptochironomus fulvus gr.</i>	midge	PR	8	16		4					4			4	4	8	5
Diptera	Chironomidae	<i>Cryptotendipes sp.</i>	midge	GC	6														
Diptera	Chironomidae	<i>Dicrotendipes sp.</i>	midge	GC	5.6				4										
Diptera	Chironomidae	<i>Dicrotendipes neomodestus</i>	midge	FG	4.5	8	32	8	20	36	12	8	28	32		12	12	12	
Diptera	Chironomidae	<i>Endochironomus nigricans</i>	midge	SH	8	8	16		12				8	4		12	12		1
Diptera	Chironomidae	<i>Eukiefferiella gracei gr.</i>	midge	GC	4														
Diptera	Chironomidae	<i>Eukiefferiella sp.</i>	midge	GC	4														
Diptera	Chironomidae	<i>Glyptotendipes sp.</i>	midge	FC	10						8								
Diptera	Chironomidae	<i>Labrundinia pilosella</i>	midge	PR	3.1														
Diptera	Chironomidae	<i>Larsia sp.</i>	midge	PR	4.3														
Diptera	Chironomidae	<i>Microtendipes pedellus gr.</i>	midge	FG	6			8										8	
Diptera	Chironomidae	<i>Micropsectra sp.</i>	midge	GC	3.5														
Diptera	Chironomidae	<i>Nanocladius sp.</i>	midge	GC	3				12			32						8	
Diptera	Chironomidae	<i>Nilotanypus fimbriatus</i>	midge	PR	2.8														
Diptera	Chironomidae	Orthoclaadiinae	midge	GC	6					20									
Diptera	Chironomidae	<i>Orthocladus cplx.</i>	midge	GC	6	40		12	12	20		32		8		44			
Diptera	Chironomidae	<i>Orthocladus sp.</i>	midge	GC	6										32				
Diptera	Chironomidae	<i>Parachironomus sp.</i>	midge	PR	4.1														
Diptera	Chironomidae	<i>Parakiefferiella sp.</i>	midge	GC	4.8				12										
Diptera	Chironomidae	<i>Paratanytarsus sp.</i>	midge	GC	6		32			20					12		32		
Diptera	Chironomidae	<i>Paraphaenocladus sp.</i>	midge	GC	4														
Diptera	Chironomidae	<i>Paratendipes basidens</i>	midge	GC	8														
Diptera	Chironomidae	<i>Pentaneura inconspicua</i>	midge	PR	4.9														
Diptera	Chironomidae	<i>Polypedilum flavum</i>	midge	SH	6	24	80	44	12	60	40	8	40	32	16	24	24	108	21
Diptera	Chironomidae	<i>Polypedilum sp.</i>	midge	SH	6			4											1
Diptera	Chironomidae	<i>Polypedilum tritum</i>	midge	SH	6														
Diptera	Chironomidae	<i>Potthastia longimanna</i>	midge	GC	2									4					
Diptera	Chironomidae	<i>Procladius sp.</i>	midge	PR	9												4		
Diptera	Chironomidae	<i>Pseudochironomus sp.</i>	midge	GC	5						16		4		12	32	12		
Diptera	Chironomidae	<i>Rheotanytarsus sp.</i>	midge	FC	6	76	72	8		60	48	120	60	124	8	64	16	32	10
Diptera	Chironomidae	<i>Stictochironomus devinctus gr.</i>	midge	OM	5														
Diptera	Chironomidae	<i>Synorthocladus semivirens</i>	midge	GC	2.5												16	8	3
Diptera	Chironomidae	Tanypodinae	midge	PR	7														
Diptera	Chironomidae	<i>Tanytarsus sp.</i>	midge	FC	6			4											
Diptera	Chironomidae	<i>Thienemanniella xena</i>	midge	GC	3.6	12	88	16		12	16	28	20	28	16	4	4	4	1
Diptera	Chironomidae	<i>Thienemannimyia gr.</i>	midge	PR	6							4							9
Diptera	Chironomidae	<i>Tribelos jucundum</i>	midge	GC	5.6														
Diptera	Chironomidae	<i>Tvetenia vitracies</i>	midge	GC	5	16				20				4					1
Diptera	Chironomidae	<i>Xenochironomus xenolabis</i>	midge	PR	0														
Diptera	Empididae	<i>Hemerodromia sp.</i>	dance fly	PR	6			2					1					1	
Diptera	Psychodidae	<i>Pericoma sp.</i>	moth fly	GC	5.6														

Appendix E1. Benthic Invertebrate Community Data-Sweeps (EPA): Data and Metric Calculations

Diptera	Simuliidae	Simulium sp.	black fly	FC	4.8	5				120	1	27	8	4	33			6	9															
Diptera	Tabanidae	Chrysops sp.	deer fly	GC	6																													
Diptera	Tipulidae	Erioptera sp.	crane fly	GC	7																													
Diptera	Tipulidae	Tipula sp.	crane fly	SH	7.2																													
Metrics:																				# Filterers/Collectors	286	510	17	20	849	116	350	206	241	113	149	234	388	234
																				Abundance	696	1772	425	405	1605	487	635	518	1127	484	658	677	918	802
																				Hilsenhoff Sum	3176.7	8365.2	2952.5	2425.3	7545.8	2881.9	2879.8	2888.2	6140	2945.5	4086.3	3954.8	4234.1	3687.3
																				Mayfly Abundance	136	314	8	22	134	29	35	39	279	22	103	91	73	191
																				Caddisfly Abundance	215	456	2	9	683	52	203	142	113	43	79	210	363	236
																				Isopods, Snails, Leeches Abundance	14	48	16	61	5	23	7	11	66	32	5	28	33	43
																				Surface Dependent Abundance	0	14	9	1	0	0	0	0	0	0	2	0	5	0
																				Taxa Richness	42	42	36	39	39	41	33	37	40	37	40	40	47	38
																				# of Mayfly Taxa	7	7	5	7	5	8	6	6	6	5	6	6	9	7
																				# of Stonefly Taxa	1	1	0	0	0	1	1	0	1	0	1	1	1	1
																				# of Caddisfly Taxa	9	9	2	4	8	7	5	9	10	7	8	5	7	7
																				% Mayfly Comp	19.5	17.7	1.9	5.4	8.3	6.0	5.5	7.5	24.8	4.5	15.7	13.4	8.0	23.8
																				% Caddisfly Comp	30.9	25.7	0.5	2.2	42.6	10.7	32.0	27.4	10.0	8.9	12.0	31.0	39.5	29.4
																				% Dominant Taxon	13.2	16.7	39.5	18.5	15.5	29.6	18.9	21.6	30.5	28.9	27.4	19.5	25.4	18.0
																				% Isopods, Snails, Leeches	2.0	2.7	3.8	15.1	0.3	4.7	1.1	2.1	5.9	6.6	0.8	4.1	3.6	5.4
																				% Surface Dependent	0.0	0.8	2.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.5	0.0
																				HBI	4.56	4.72	6.95	5.99	4.70	5.92	4.54	5.58	5.45	6.09	6.21	5.84	4.61	4.60
																				Ratio of Filterers to Total	0.41	0.29	0.04	0.05	0.53	0.24	0.55	0.40	0.21	0.23	0.23	0.35	0.42	0.29
																				EPT Index	17	17	7	11	13	16	12	15	17	12	15	12	17	15

Notes :
EPT Ephemeroptera, Plecoptera, and Trichoptera
FC Filterer/Collector
GC Gatherer/Collector
HBI Hilsenhoff Biotic Index
OM Omnivore
PA Parasite
PR Predator
SC Scraper
SH Shredder
Number
% Percent

Appendix E-2:
Benthic Invertebrate Community Data
Sweeps (DNRE)

Appendix E2. Benthic Community Data-Sweeps (DNRE): Data and Metric Calculations

Order	Family	Genus/Species	Common Name	Feeding Group	Tolerance Value	CR-Ref-01-IC-SP1	CR-Ref-02-IC-SP1	RA-Ref-01-IC-SP1	RB-013-00-IC-SP1	RE-062-00-IC-SP1	RE-077-50-IC-SP1	RF-085-00-IC-SP1	RG-140-00-IC-SP1	RH-153-50-IC-SP1	RI-169-50-IC-SP1	RK-201-00-IC-SP1	RM-285-00-IC-SP1	TR-Ref-01-SP1	TR-Ref-02-SP1
Nematoda			round worm	PA	9	1						1	5				1		2
Tricladida	Planariidae	<i>Dugesia tigrina</i>	flat worm	PR	6				1						7		2	3	2
Hoplonemertea	Tetrastemmatidae	<i>Prostoma graecense</i>	proboscis worm	PR	8						2			1					
Hirudinea	Glossiphoniidae	<i>Helobdella elongata</i>	leech	PR	8		2												
Hirudinea	Glossiphoniidae	<i>Helobdella fusca</i>	leech	PA	8				2										1
Hirudinea	Glossiphoniidae	<i>Helobdella stagnalis</i>	leech	PR	8														
Tubificida	Naididae	<i>Dero obtusa</i>	naiad worm	GC	10											3			
Tubificida	Naididae	<i>Nais bretscheri</i>	naiad worm	GC	6												2		
Tubificida	Naididae	<i>Nais sp.</i>	naiad worm	GC	8				24		13			1	7	5	8		
Tubificida	Naididae	<i>Pristina longisoma</i>	naiad worm	GC	9.9											3			
Tubificida	Naididae	<i>Slavina appendiculata</i>	naiad worm	GC	6														
Tubificida	Naididae	<i>Stylaria lacustris</i>	naiad worm	GC	6														
Tubificida	Enchytraeidae		aquatic worm	GC	10								2						
Tubificida	Tubificidae	<i>Branchiura sowerbyi</i>	tube worm	GC	6			1	1		1				7				
Tubificida	Tubificidae	<i>Limnodrilus hoffmeisteri</i>	tube worm	GC	10				14										
Tubificida	Tubificidae	<i>Limnodrilus sp.</i>	tube worm	GC	10								6						
Tubificida	Tubificidae	<i>immature with hair chaetae</i>	tube worm	GC	10												4		
Hydroida	Hydridae	<i>Hydra sp.</i>	polyp	PR	5														
Basommatophora	Ancylidae	<i>Ferrissia rivularis</i>	limpet snail	SC	7	1	20	11	34	1	13	4	11	60	9	5	18	21	30
Basommatophora	Lymnaeidae	<i>Fossaria sp.</i>	pond snail	SC	2.6	1	5	1	8									4	
Basommatophora	Physidae	<i>Physa sp.</i>	pouch snail	SC	9	11	20	3	12			1						3	4
Basommatophora	Planorbidae	<i>Gyraulus parvus</i>	ram's horn snail	SC	5.5			1											
Basommatophora	Planorbidae	<i>Helisoma sp.</i>	ram's horn snail	SC	7		1		4	1									
Basommatophora	Hydrobiidae	<i>Amnicola sp.</i>	dusky snail	SC	4						9	1							
Mesogastropoda	Pleuroceridae	<i>Goniobasis livescens</i>	horn snail	SC	6	1				3	1			6	22		10	5	8
Mesogastropoda	Pleuroceridae	<i>Leptoxis carinata</i>	horn snail	SC	6														
Veneroida	Dreissenidae	<i>Dreissena polymorpha</i>	zebra mussel	FC	8			4	16	11	6		1	11	34	10	8	13	4
Veneroida	Sphaeriidae	<i>Pisidium sp.</i>	pill clam	FC	4.6						2				1			4	3
Hydracarina			water mite	PR	6			1	3	12	1	7		3			3		
Amphipoda	Crangonyctidae	<i>Crangonyx sp.</i>	sideswimmer	GC	4														
Amphipoda	Gammaridae	<i>Gammarus fasciatus</i>	sideswimmer	GC	3	18	296	4	75	16	1		2	3		1		115	25
Amphipoda	Hyalellidae	<i>Hyalella azteca</i>	sideswimmer	GC	8	2		168	14		1		2				1	1	
Decapoda	Cambaridae	<i>Orconectes sp.</i>	crayfish	GC	5		24												
Isopoda	Asellidae	<i>Caecidotea sp.</i>	sowbug	GC	6				1			1			1				
Ephemeroptera	Baetidae	<i>Acerpenna sp.</i>	mayfly	SH	4														4
Ephemeroptera	Baetidae	<i>Baetis sp.</i>	mayfly	GC	3.1	1		3	1		2							1	
Ephemeroptera	Baetidae	<i>Centroptilum sp.</i>	mayfly	GC	2														
Ephemeroptera	Baetidae	<i>Plauditus sp.</i>	mayfly	GC	4	58	2			14	1	2		2	9			20	1
Ephemeroptera	Baetiscidae	<i>Baetisca sp.</i>	mayfly	GC	4	3	40		8	8	2	9	1		2		1	5	
Ephemeroptera	Caenidae	<i>Caenis sp.</i>	mayfly	GC	7	1	8	1		4	1	1	2	1		59	4	4	16
Ephemeroptera	Ephemeridae	<i>Ephemer sp.</i>	mayfly	CG	1														2
Ephemeroptera	Ephemeridae	<i>Hexagenia sp.</i>	mayfly	GC	6														
Ephemeroptera	Ephemerellidae	<i>Serratella sp.</i>	mayfly	GC	0.6														
Ephemeroptera	Heptageniidae	<i>Maccaffertium mediopunctatum</i>	mayfly	SC	3														
Ephemeroptera	Heptageniidae	<i>Maccaffertium sp.</i>	mayfly	SC	4	29	24		2	16		1	9	73	1	10	16	33	144
Ephemeroptera	Heptageniidae	<i>Stenacron interpunctatum</i>	mayfly	OM	7		24		5							1		1	4
Ephemeroptera	Heptageniidae	<i>Stenonema femoratum</i>	mayfly	OM	5											1			
Ephemeroptera	Isonychiidae	<i>Isonychia sp.</i>	mayfly	FC	2						1		1				1		
Ephemeroptera	Leptophlebiidae	<i>Leptophlebia sp.</i>	mayfly	GC	4		16	1	1		1			8		8		3	
Ephemeroptera	Potamanthidae	<i>Anthopotamus verticis gr.</i>	mayfly	GC	3.2	2		1	4		6	11	11	8	1		1	1	
Ephemeroptera	Tricorythidae	<i>Tricorythodes sp.</i>	mayfly	GC	4	42	200	2	1	92	15	11	15	187	9	24	68	5	20
Odonata	Aeshnidae	<i>Aeshna sp.</i>	dragonfly	PR	4										1				
Odonata	Aeshnidae	<i>Boyeria vinosa</i>	dragonfly	PR	3.5														
Odonata	Calopterygidae	<i>Haeterina sp.</i>	damselfly	PR	6	2	3						2		1				
Odonata	Coenagrionidae	<i>Argia sp.</i>	damselfly	PR	5.1	2		2		5	1				1	1		1	
Odonata	Coenagrionidae	<i>Enallagma sp.</i>	damselfly	PR	9	3	27	16	20	4	5	1	2	5	25	9	29		
Odonata	Corduliidae	<i>Neurocordulia sp.</i>	dragonfly	PR	3														
Odonata	Gomphidae		dragonfly	PR	4					2						1			
Odonata	Gomphidae	<i>Gomphus sp.</i>	dragonfly	PR	5														
Plecoptera	Capniidae	<i>Allocapnia</i>	stonefly	SH	3														
Plecoptera	Chloroperlidae	<i>Haploperla brevis</i>	stonefly	PR	1														
Plecoptera	Perlidae	<i>Acroneuria sp.</i>	stonefly	PR	1														
Plecoptera	Perlidae	<i>Paragnetina sp.</i>	stonefly	PR	2.1		1												
Plecoptera	Taeniopterygidae	<i>Taeniopteryx sp.</i>	stonefly	SH	2	1					8	10		8		8	1	14	5
Megaloptera	Sialidae	<i>Sialis sp.</i>	alderfly	PR	4													1	
Hemiptera	Belostomatidae	<i>Belostoma lutarium</i>	giant water bug	PR	9		1	3										1	
Hemiptera	Corixidae		water boatmen	PR	5											1			
Hemiptera	Corixidae	<i>Hesperocorixa sp.</i>	water boatmen	PR	5				1										
Hemiptera	Corixidae	<i>Sigara lineata</i>	water boatmen	GC	8		10												
Trichoptera	Brachycentridae	<i>Brachycentrus sp.</i>	caddisfly	FC	1	12	14			5	2	6	4	5	3	3	1		
Trichoptera	Glossosomatidae	<i>Protoptila sp.</i>	caddisfly	SC	1													10	10
Trichoptera	Helicopsychidae	<i>Helicopsyche borealis</i>	caddisfly	SC	3	1													
Trichoptera	Hydropsychidae	<i>Cheumatopsyche sp.</i>	caddisfly	FC	5	68	192	1	2	248	11	28	104	60	12	46	132	24	44
Trichoptera	Hydropsychidae	<i>Hydropsyche aerata</i>	caddisfly	FC	2.6	12	8			72	1	16	4	1			4	32	68
Trichoptera	Hydropsychidae	<i>Hydropsyche bronta</i>	caddisfly	FC	5														
Trichoptera	Hydropsychidae	<i>Hydropsyche morosa</i>	caddisfly	FC	2														

Appendix E2. Benthic Community Data-Sweeps (DNRE): Data and Metric Calculations

Trichoptera	Hydropsychidae	<i>Hydropsyche phalerata</i>	caddisfly	FC	1	92	96			156	2	101	4	17	9	2		44	68
Trichoptera	Hydropsychidae	<i>Hydropsyche sparna</i>	caddisfly	FC	1														
Trichoptera	Hydropsychidae	<i>Hydropsyche sp.</i>	caddisfly	FC	5	20	128		2	176	34	52	20	16	13	20	72	233	28
Trichoptera	Hydroptilidae	<i>Hydroptila sp.</i>	caddisfly	PR	6						1		2	1		1			
Trichoptera	Hydroptilidae	<i>Ithytrichia clavata</i>	caddisfly	SC	1		1												
Trichoptera	Lepidostomatidae	<i>Lepidostoma sp.</i>	caddisfly	SH	1														
Trichoptera	Leptoceridae	<i>Nectopsyche sp.</i>	caddisfly	SH	2.4	6	7		3	22	1		2	9	4	2	1	11	13
Trichoptera	Leptoceridae	<i>Oecetis sp.</i>	caddisfly	PR	8	3	8		2	3			1	1	1			9	5
Trichoptera	Leptoceridae	<i>Triaenodes sp.</i>	caddisfly	SH	3														
Trichoptera	Limnephilidae	<i>Pycnopsyche sp.</i>	caddisfly	SH	3.3														
Trichoptera	Polycentropodidae	<i>Cymellus fraternus</i>	caddisfly	FC	8					1				1		4			
Trichoptera	Polycentropodidae	<i>Neureclipsis sp.</i>	caddisfly	FC	7	1								2					
Trichoptera	Polycentropodidae	<i>Polycentropus sp.</i>	caddisfly	PR	6		2	1					1			1			
Trichoptera	Uenoidae	<i>Neophylax sp.</i>	caddisfly	SC	3										1				
Lepidoptera	Pyalidae	<i>Parapohnx sp.</i>	moth	SH	5	5	25	4		3	8	2		4	1	4		9	23
Lepidoptera	Pyalidae	<i>Petrophila sp.</i>	moth	SC	2.7	2				11		2		2			4	17	16
Coleoptera	Dytiscidae	<i>Hydroporus sp.</i>	diving beetle	PR	4.1			3											
Coleoptera	Elmidae	<i>Ancyronyx variegatus</i>	riffle beetle	OM	4					4									
Coleoptera	Elmidae	<i>Dubiraphia vittata</i>	riffle beetle	OM	7	10	16		29	173	19	3	6	27	25	19	32	35	127
Coleoptera	Elmidae	<i>Macronychus glabratus</i>	riffle beetle	OM	4	13	2		2	45			10	10	3	2	5	1	
Coleoptera	Elmidae	<i>Optioservus sp.</i>	riffle beetle	SC	4					11		1					3	3	
Coleoptera	Elmidae	<i>Stenelmis crenata gr.</i>	riffle beetle	SC	5	31	2	3	1	66	22	8	3	10	1	3	5	16	64
Coleoptera	Gyrinidae	<i>Dineutus sp.</i>	whirligig beetle	PR	3.7														
Coleoptera	Halplidae	<i>Halplus sp.</i>	crawling beetle	SH	5		2												
Coleoptera	Hydrophilidae	<i>Berosus sp.</i>	scavenger beetle	PR	6.7		1									1			
Coleoptera	Psephenidae	<i>Ectopria nervosus</i>	false water penny	SC	5			3											
Coleoptera	Psephenidae	<i>Psephenus herricki</i>	water penny	SC	4													4	
Diptera	Athericidae	<i>Atherix sp.</i>	watersnipe fly	PR	4														
Diptera	Ceratopogonidae	<i>Bezzia sp.</i>	biting midge	GC	6			1											
Diptera	Ceratopogonidae	<i>Ceratopogon sp.</i>	biting midge	PR	6														
Diptera	Ceratopogonidae	<i>Dasyhelea sp.</i>	biting midge	PR	6										4				
Diptera	Ceratopogonidae	<i>Palpomyia gr.</i>	biting midge	PR	6														
Diptera	Ceratopogonidae	<i>Probezzia sp.</i>	biting midge	PR	6														
Diptera	Chironomidae	<i>Ablabesmyia janta</i>	midge	OM	4.9											4			
Diptera	Chironomidae	<i>Ablabesmyia mallochi</i>	midge	OM	8														
Diptera	Chironomidae	Chironomini	midge	GC	6														
Diptera	Chironomidae	<i>Chironomus sp.</i>	midge	GC	10						8					32	36		
Diptera	Chironomidae	<i>Cladotanytarsus sp.</i>	midge	GC	7														
Diptera	Chironomidae	<i>Corynoneura sp.</i>	midge	GC	7		24	72	16										
Diptera	Chironomidae	<i>Cricotopus bicintus</i>	midge	OM	6.7	36	200	4	12	52	144	96	112	344	140	180	68	16	
Diptera	Chironomidae	<i>Cricotopus sp.</i>	midge	SH	7														
Diptera	Chironomidae	<i>Cricotopus trifasciata</i>	midge	OM	7														
Diptera	Chironomidae	<i>Cryptochironomus fulvus gr.</i>	midge	PR	8	16		4					4			4	4	8	5
Diptera	Chironomidae	<i>Cryptotendipes sp.</i>	midge	GC	6														
Diptera	Chironomidae	<i>Dicrotendipes sp.</i>	midge	GC	5.6				4										
Diptera	Chironomidae	<i>Dicrotendipes neomodestus</i>	midge	FG	4.5	8	32	8	20	36	12	8	28	32		12	12	12	
Diptera	Chironomidae	<i>Endochironomus nigricans</i>	midge	SH	8	8	16		12				8	4			12		1
Diptera	Chironomidae	<i>Eukiefferiella gracei gr.</i>	midge	GC	4														
Diptera	Chironomidae	<i>Eukiefferiella sp.</i>	midge	GC	4														
Diptera	Chironomidae	<i>Glyptotendipes sp.</i>	midge	FC	10						8								
Diptera	Chironomidae	<i>Labrundinia pilosella</i>	midge	PR	3.1														
Diptera	Chironomidae	<i>Larsia sp.</i>	midge	PR	4.3														
Diptera	Chironomidae	<i>Microtendipes pedellus gr.</i>	midge	FG	6			8										8	
Diptera	Chironomidae	<i>Micropsectra sp.</i>	midge	GC	3.5														
Diptera	Chironomidae	<i>Nanocladius sp.</i>	midge	GC	3				12			32						8	
Diptera	Chironomidae	<i>Nilotanypus fimbriatus</i>	midge	PR	2.8														
Diptera	Chironomidae	Orthoclaadiinae	midge	GC	6					20									
Diptera	Chironomidae	<i>Orthocladus cplx.</i>	midge	GC	6	40		12	12	20		32		8		44			
Diptera	Chironomidae	<i>Orthocladus sp.</i>	midge	GC	6										32				
Diptera	Chironomidae	<i>Parachironomus sp.</i>	midge	PR	4.1														
Diptera	Chironomidae	<i>Parakiefferiella sp.</i>	midge	GC	4.8				12										
Diptera	Chironomidae	<i>Paratanytarsus sp.</i>	midge	GC	6		32			20					12		32		
Diptera	Chironomidae	<i>Paraphaenocladus sp.</i>	midge	GC	4														
Diptera	Chironomidae	<i>Paratendipes basidens</i>	midge	GC	8														
Diptera	Chironomidae	<i>Pentaneura inconspicua</i>	midge	PR	4.9														
Diptera	Chironomidae	<i>Polypedilum flavum</i>	midge	SH	6	24	80	44	12	60	40	8	40	32	16	24	24	108	21
Diptera	Chironomidae	<i>Polypedilum sp.</i>	midge	SH	6			4											1
Diptera	Chironomidae	<i>Polypedilum tritum</i>	midge	SH	6														
Diptera	Chironomidae	<i>Potthastia longimana</i>	midge	GC	2								4						
Diptera	Chironomidae	<i>Procladius sp.</i>	midge	PR	9												4		
Diptera	Chironomidae	<i>Pseudochironomus sp.</i>	midge	GC	5						16		4		12	32	12		
Diptera	Chironomidae	<i>Rheotanytarsus sp.</i>	midge	FC	6	76	72	8		60	48	120	60	124	8	64	16	32	10
Diptera	Chironomidae	<i>Stictochironomus devinctus gr.</i>	midge	OM	5														
Diptera	Chironomidae	<i>Synorthocladus semivirens</i>	midge	GC	2.5												16	8	3
Diptera	Chironomidae	Tanypodinae	midge	PR	7														
Diptera	Chironomidae	<i>Tanytarsus sp.</i>	midge	FC	6			4											

Appendix E2. Benthic Community Data-Sweeps (DNRE): Data and Metric Calculations

Diptera	Chironomidae	<i>Thienemanniella xena</i>	midge	GC	3.6	12	88	16		12	16	28	20	28	16	4	4	4	1
Diptera	Chironomidae	<i>Thienemannimyia gr.</i>	midge	PR	6							4							9
Diptera	Chironomidae	<i>Tribelos jucundum</i>	midge	GC	5.6														
Diptera	Chironomidae	<i>Tvetenia vitracies</i>	midge	GC	5	16				20				4					1
Diptera	Chironomidae	<i>Xenochironomus xenolabis</i>	midge	PR	0														
Diptera	Empididae	<i>Hemerodromia sp.</i>	dance fly	PR	6			2					1					1	
Diptera	Psychodidae	<i>Pericoma sp.</i>	moth fly	GC	5.6														
Diptera	Simuliidae	<i>Simulium sp.</i>	black fly	FC	4.8	5				120	1	27	8	4	33			6	9
Diptera	Tabanidae	<i>Chrysops sp.</i>	deer fly	GC	6														
Diptera	Tipulidae	<i>Erioptera sp.</i>	crane fly	GC	7														
Diptera	Tipulidae	<i>Tipula sp.</i>	crane fly	SH	7.2														
Metrics :					Total Abundance	696	1772	425	405	1605	487	635	518	1127	484	658	677	918	802
					Mayfly Abundance	136	314	8	22	134	29	35	39	279	22	103	91	73	191
					Caddisfly Abundance	215	456	2	9	683	52	203	142	113	43	79	210	363	236
					Isopod, Snail, Leech Abundance	14	48	16	61	5	23	7	11	66	32	5	28	33	43
					Surface Dependent Organism Abundance	54	34	12	33	299	41	12	19	47	29	26	45	60	191
					Taxa Richness	42	42	36	39	39	41	33	37	40	37	40	40	47	38
					Mayfly Taxa Richness	7	7	5	7	5	8	6	6	6	5	6	6	9	7
					Caddisfly Taxa Richness	9	9	2	4	8	7	5	9	10	7	8	5	7	7
					Stonefly Taxa Richness	1	1	0	0	0	1	1	0	1	0	1	1	1	1
					% Mayfly	19.5	17.7	1.9	5.4	8.3	6.0	5.5	7.5	24.8	4.5	15.7	13.4	8.0	23.8
					% Caddisfly	30.9	25.7	0.5	2.2	42.6	10.7	32.0	27.4	10.0	8.9	12.0	31.0	39.5	29.4
					% Dominance	13.2	16.7	39.5	18.5	15.5	29.6	18.9	21.6	30.5	28.9	27.4	19.5	25.4	18.0
					% Isopod, Snail, Leech	2.0	2.7	3.8	15.1	0.3	4.7	1.1	2.1	5.9	6.6	0.8	4.1	3.6	5.4
					% Surface Dependent	7.8	1.9	2.8	8.1	18.6	8.4	1.9	3.7	4.2	6.0	4.0	6.6	6.5	23.8

Notes :
FC Filterer/Collector
GC Gatherer/Collector
OM Omnivore
PA Parasite
PR Predator
SC Scraper
SH Shredder
% Percent

Appendix F:

Statistical Analysis Output for Reaches

Appendix F: Statistical Analysis Output for Reaches

Hester Dendy Data, Reach vs % of Composite Reference

One Way Analysis of Variance

Dependent Variable: % of Composite Reference (after exponential transformation)

Normality Test (Shapiro-Wilk) Passed (P = 0.107)

Equal Variance Test: Passed (P = 0.184)

Group Name	N	Missing	Mean	Std Dev	SEM
Reach E	13	0	2.513	0.345	0.0957
Reach F	5	0	2.062	0.387	0.173
Reach G	10	0	2.588	0.202	0.0638
Reach H	13	0	2.242	0.312	0.0867
Reach I	15	0	2.048	0.389	0.100
Reach K	5	0	2.270	0.248	0.111
Reach M	5	0	2.562	0.0522	0.0233
References	30	0	2.443	0.331	0.0604
Source of Variation	DF	SS	MS	F	P
Between Groups	7	3.362	0.480	4.637	<0.001
Residual	88	9.113	0.104		
Total	95	12.474			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 0.970

Multiple Comparisons versus Control Group (Dunnett's Method) :

Comparisons for factor: Reach

Comparison	Diff of Means	q'	P	P<0.050
References vs. Reach I	0.395	3.883	--	Yes
References vs. Reach F	0.381	2.448	--	No
References vs. Reach H	0.201	1.883	--	Do Not Test
References vs. Reach K	0.173	1.112	--	Do Not Test
References vs. Reach G	0.145	1.236	--	Do Not Test
References vs. Reach M	0.119	0.767	--	Do Not Test
References vs. Reach E	0.0700	0.655	--	Do Not Test

Note: The P values for Dunnett's and Duncan's tests are currently unavailable except for reporting that the P's are greater or less than the critical values of .05 and .01.

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.

Grab Data, Reach vs % of Composite Reference

One Way Analysis of Variance

Dependent Variable: % of Composite Reference

Normality Test (Shapiro-Wilk) Passed ($P = 0.221$)

Equal Variance Test: Failed ($P < 0.050$)

The following transformations did not make data amenable to parametric statistics, logarithm base 10, natural logarithm, exponential, inverse, and square root.

Test execution ended by user request, ANOVA on Ranks begun

Kruskal-Wallis One Way Analysis of Variance on Ranks

Group	N	Missing	Median	25%	75%
Reach E	6	0	0.867	0.750	1.008
Reach F	9	0	0.800	0.733	0.867
Reach G	3	0	0.933	0.900	1.000
Reach H	9	0	0.800	0.733	0.833
Reach I	6	0	0.700	0.517	0.858
Reach K	3	0	0.933	0.933	1.033
Reach M	3	0	0.900	0.867	0.933
References	18	0	0.850	0.592	0.967

$H = 11.549$ with 7 degrees of freedom. ($P = 0.116$)

The differences in the median values among the treatment groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference ($P = 0.116$)

Appendix G:

Statistical Analysis Output for Locations

Appendix G: Statistical Analysis Output for Locations

Hester Dendy Data, Location vs % of Composite Reference

One Way Analysis of Variance

Dependent Variable: % of Composite Reference (after exponential transformation)

Normality Test (Shapiro-Wilk) Passed (P = 0.065)

Equal Variance Test: Passed (P = 0.628)

Group Name	N	Missing	Mean	Std Dev	SEM
RE-061	5	0	2.548	0.176	0.0786
RE-062	5	0	2.780	0.0562	0.0251
RE-073	3	0	2.010	0.291	0.168
RF-082	5	0	2.062	0.387	0.173
RG-136	5	0	2.702	0.159	0.0712
RG-137-50	5	0	2.474	0.184	0.0822
RH-143	3	0	2.556	0.0550	0.0317
RH-144	5	0	2.337	0.243	0.109
RH-150	5	0	1.958	0.214	0.0956
RI-164	5	0	2.315	0.177	0.0790
RI-164-50	5	0	1.562	0.0914	0.0409
RI-168-50	5	0	2.267	0.214	0.0956
RK-201	5	0	2.270	0.248	0.111
RM-285	5	0	2.562	0.0522	0.0233
References	30	0	2.443	0.331	0.0604
Source of Variation	DF	SS	MS	F	P
Between Groups	14	7.136	0.510	7.735	<0.001
Residual	81	5.338	0.0659		
Total	95	12.474			

The differences in the mean values among the treatment groups are greater than would be expected by chance; there is a statistically significant difference (P = <0.001).

Power of performed test with alpha = 0.050: 1.000

Multiple Comparisons versus Control Group (Dunnett's Method) :

Comparisons for factor: Location

Comparison	Diff of Means	q'	P	P<0.050
References vs. RI-164-50	0.881	7.107	--	Yes
References vs. RH-150	0.485	3.915	--	Yes
References vs. RE-073	0.433	2.787	--	No
References vs. RF-082	0.381	3.069	--	Do Not Test
References vs. RE-062	0.337	2.716	--	Do Not Test

References vs. RG-136	0.259	2.090	--	Do Not Test
References vs. RI-168-50	0.176	1.421	--	Do Not Test
References vs. RK-201	0.173	1.394	--	Do Not Test
References vs. RI-164	0.128	1.033	--	Do Not Test
References vs. RM-285	0.119	0.962	--	Do Not Test
References vs. RH-143	0.113	0.726	--	Do Not Test
References vs. RH-144	0.106	0.851	--	Do Not Test
References vs. RE-061	0.105	0.847	--	Do Not Test
References vs. RG-137-50	0.0314	0.253	--	Do Not Test

Note: The P values for Dunnett's and Duncan's tests are currently unavailable except for reporting that the P's are greater or less than the critical values of .05 and .01.

A result of "Do Not Test" occurs for a comparison when no significant difference is found between two means that enclose that comparison. For example, if you had four means sorted in order, and found no difference between means 4 vs. 2, then you would not test 4 vs. 3 and 3 vs. 2, but still test 4 vs. 1 and 3 vs. 1 (4 vs. 3 and 3 vs. 2 are enclosed by 4 vs. 2: 4 3 2 1). Note that not testing the enclosed means is a procedural rule, and a result of Do Not Test should be treated as if there is no significant difference between the means, even though one may appear to exist.

Grab Data, Location vs % of Composite Reference

One Way Analysis of Variance

Dependent Variable: % of Composite Reference

Normality Test (Shapiro-Wilk) Passed (P = 0.257)

Equal Variance Test: Passed (P = 0.170)

Group Name	N	Missing	Mean	Std Dev	SEM
RE-062	3	0	0.978	0.0694	0.0401
RE-077	3	0	0.767	0.0667	0.0385
RF-085	3	0	0.856	0.102	0.0588
RF-090	3	0	0.800	0.1000	0.0577
RF-128-50	3	0	0.711	0.158	0.0909
RG-140	3	0	0.944	0.0509	0.0294
RH-142	3	0	0.667	0.120	0.0694
RH-143	3	0	0.811	0.0192	0.0111
RH-151	3	0	0.822	0.0192	0.0111
RI-166	3	0	0.589	0.234	0.135
RI-169-50	3	0	0.778	0.190	0.109
RK-201	3	0	0.967	0.0577	0.0333
RM-285	3	0	0.900	0.0333	0.0192
References	18	0	0.804	0.217	0.0511
Source of Variation	DF	SS	MS	F	P
Between Groups	13	0.491	0.0377	1.433	0.184
Residual	43	1.132	0.0263		

Total	56	1.623			
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The differences in the mean values among the treatment groups are not great enough to exclude the possibility that the difference is due to random sampling variability; there is not a statistically significant difference ($P = 0.184$).

Power of performed test with $\alpha = 0.050$: 0.211

The power of the performed test (0.211) is below the desired power of 0.800.

Less than desired power indicates you are less likely to detect a difference when one actually exists. Negative results should be interpreted cautiously.